Design Engineering

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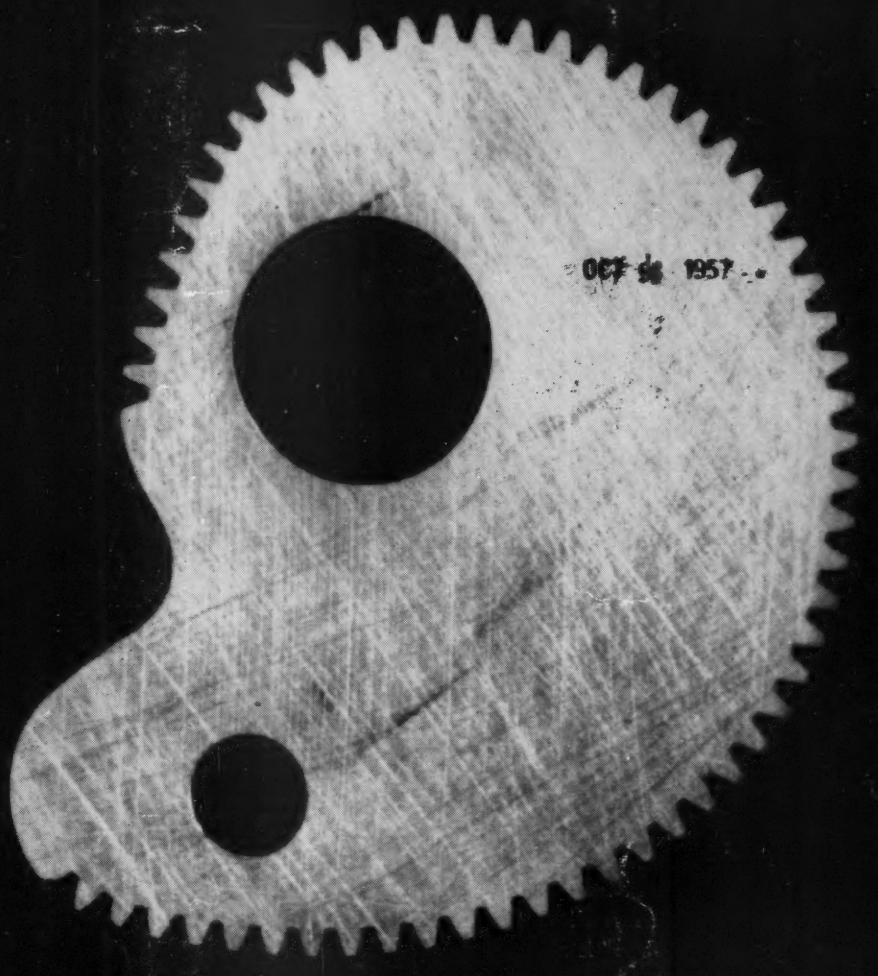

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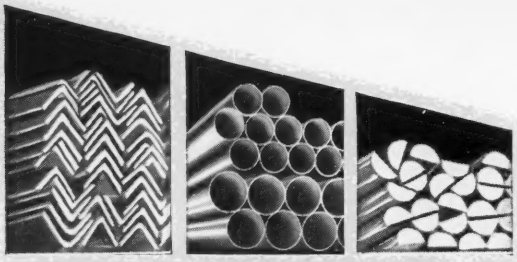
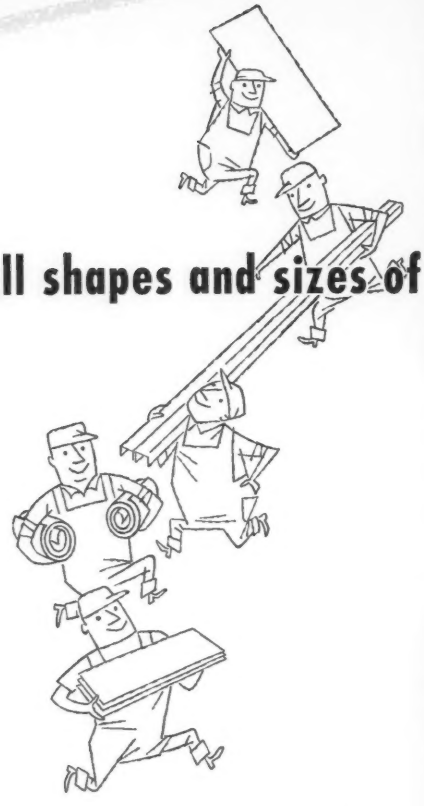
PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY, LIMITED, TORONTO, CANADA



ALCAN aluminum



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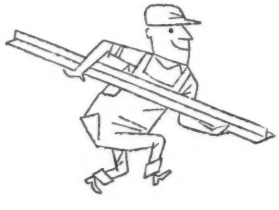

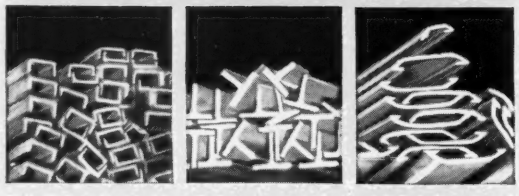

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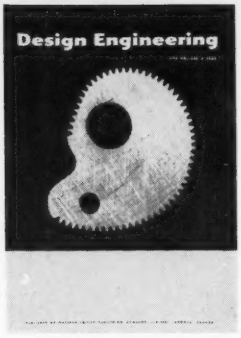

Design Engineering

Vol. 3 OCTOBER 1957 No. 10

This month's cover

The dramatically upended porcupine on the cover is the firstborn in Design Engineering of Alex MacInnes. Naturalists among our readers will deny that it's the *Erethizon Dorsatus* and they'd be right. The more likely theory that it's a gear (non circular) can be verified by a look at page 62 where W. H. Sheppard's article on this type of gear begins.

Design Engineering

MEMBER

CCAB

Authorized as second class mail, Post Office Department, Ottawa.

Printed and published by Maclean-Hunter Publishing Company Limited. Editorial and Advertising Offices: 212 King Street West, Toronto 2, Canada. Address all correspondence: P.B. Box 100, Toronto, Canada. Horace T. Hunter, Chairman of the Board; Floyd S. Chalmers, President; Donald F. Hunter, Vice-President and Managing Director; Thomas H. Howse, Vice-President and Comptroller.

Publishers of National magazines in Canada: Maclean's, Chatelaine, Canadian Homes and Gardens, Business newspapers in Canada: Canadian Hotel Review; Fountains in Canada; Heating and Plumbing Engineer; Bus and Truck Transport; Canadian Advertising; Canadian Automotive Trade; Canadian Aviation; Canadian Grocer; Canadian Machinery; Canadian Packaging; Canadian Paint and Varnish; Canadian Printer and Publisher; Canadian Shipping; Canadian Stationer; Civic Administration; Drug Merchandising; Canadian Electronics Engineering; L'Epicier; The Financial Post; Hardware and Metal; Marketing; Men's Wear; Modern Power; Painting and Decorating Contractor; Plant Administration; Le Quincaillier; Electrical Contractor; Style; Office Equipment & Methods; Home Goods Retailing; Photo Trade; Building Supply Dealer; Business newspapers in U. S. and U. K.: Inland Printer, Rock Products, Concrete Products, British Printer.

OTHER SERVICES: The Financial Post Corporation Service; Canadian Press Clipping Service; Commercial Printing Division.

Offices at 1242 Peel Street, Montreal; The Burrard Building, 1030 West Georgia Street, Vancouver 5; Maclean-Hunter Limited, 125 Strand, London (Eng.)

Subscription rates: Canada $5.00 per year, two years $9.00, three years $13.00. Single copy price, $1.00. United States and Great Britain $10.00 per year. Other countries $20.00 per year.

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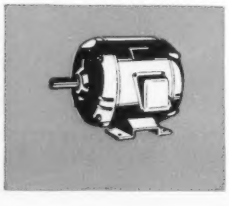
WHERE *Quietness* COUNTS

install Wagner

SLEEVE BEARING *resilient* MOUNTED MOTORS

The silent-running sleeve bearings plus the special Wagner resilient mounting make these motors exceptionally quiet. Particularly suited for circulating pumps on heating systems, air conditioning pumps and blowers in hospitals, clinics, executive offices, etc.

Wagner resilient mounted motors are available in 1 to 5 H.P. as well as fractional horsepower sizes.



The newly designed Wagner Motors are smaller in size—more rugged. Resist distortion due to handling and mounting. Built to C.E.M.A. standard mounting dimensions. For a quieter, longer, happier life turn your motor problems over to Wagner!

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WAMBOLD

John Wambold (Materials that stand up when the heat's on) co-author with T. F. Frangos of our article on cermets, is a metallurgical engineer with Kennametal Inc. in Latrobe, Pennsylvania. Before joining Kennametal (in late '56) Wambold held a similar position with Curtiss-Wright at its aeronautical division. A graduate of Pennsylvania State University and a member of the American Ceramics Society, his main duties are now with the development of titanium carbide based compositions.

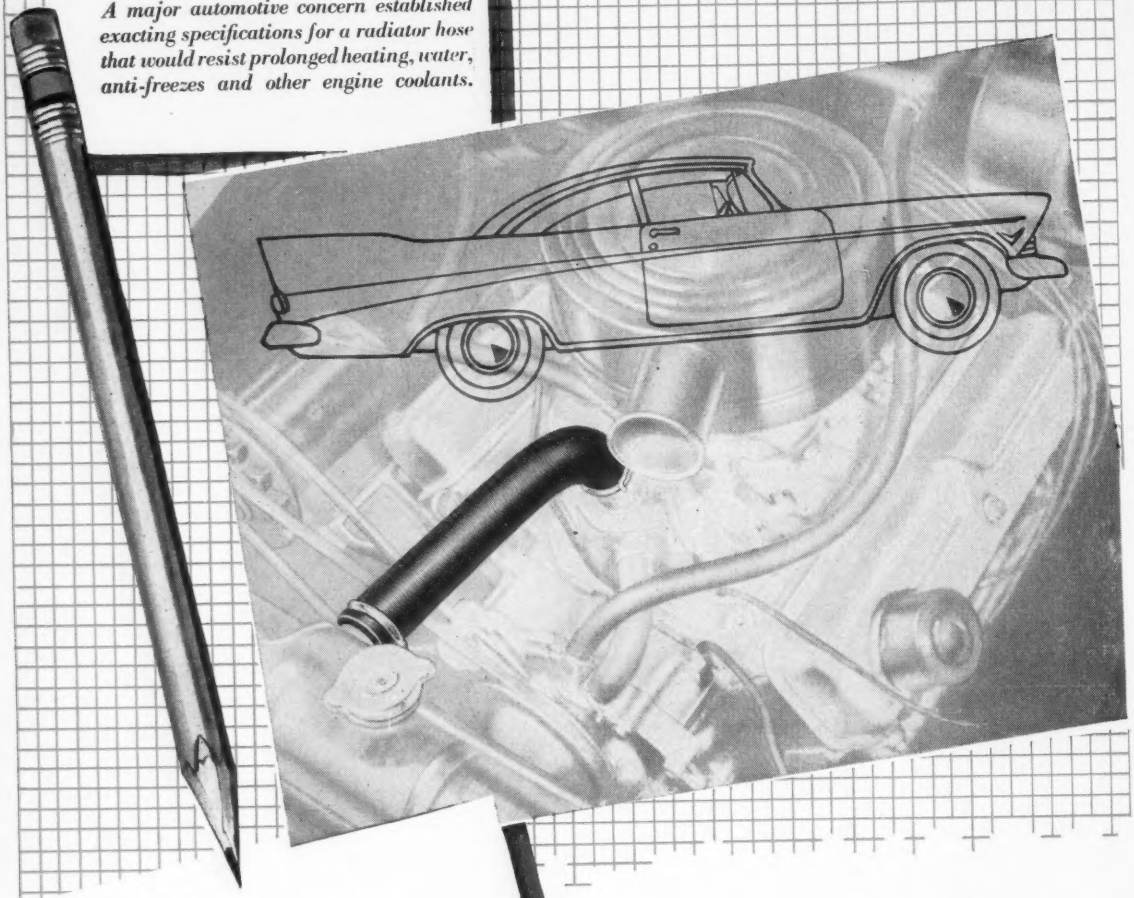
Faced with the task of getting some biographical details of Douglas King (The how and why of temperature control) into print we felt we could do no better than quote verbatim from the blurb we received as follows: "Mr. King received his degree of B.Sc. in mechanical engineering from the University of Maine in 1950. He joined Fenwal as a project engineer specializing in temperature control systems. He is 36, married, and has 3 children (2 girls and a boy). Hobbies are skiing, fishing and photography. He's a member of ASME. Lives in New Jersey."

FRANGOS

T. F. Frangos (Materials that stand up when the heat's on) is the other half of the Wambold-Frangos team that wrote this issue's cermet article. He majored in chemical engineering at Purdue University in '39, took his masters degree in '40 and then joined National Aniline. Guest of Uncle Sam as a Signal Corps captain from '42 to '46, he joined Haynes Stellite Co. in Kokomo, Indiana at war's end. Until 1953 he gave his time to the sales engineering of precision investment castings and then switched to cermets.

Problem

A major automotive concern established exacting specifications for a radiator hose that would resist prolonged heating, water, anti-freezes and other engine coolants.



Solution

Firestone Tire & Rubber Company of Canada Limited used Polysar Butyl to produce a hose which met the specifications in every detail. Polysar Butyl's unique properties made it the ideal choice for the job and gave Firestone's customer a hose with inherent long service life.

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SARNIA CANADA

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Polysar synthetic rubbers show their versatility in many ways. Whether it be improving radiator hose or giving longer life to children's footwear they offer technical advantages in practically every type of industry.

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Reports

News in brief from the world's producers

Lubrication

The tentative program for the ASLE-ASME lubrication conference (to be held at the Royal York Hotel, Toronto on October 7, 8 and 9) is given below:

Session I. Recent experiments in wear. Wear of cobalt base and other materials in the high purity water—effect of wear particles at high contact pressure—radioactive piston-ring wear studies — role of atmospheric oxygen in high-speed sliding.

Session II. Boundary lubrication. (Including highlights of I. Mech. E. London conference).

Report on highlights of papers dealing with boundary lubrication — theory of cutting tool wear and oil action—boundary lubrication and hydrodynamic behavior of bearings with liquid metals and other fluids.

Session III. High temperature lubrication.

Review of current developments in high-speed, high-temperature aircraft bearings—friction and lubrication at 1000 F, particularly with graphite — solid film lubricants at high temperature.

Session IV. Factors affecting contact fatigue.

Factors governing fatigue life in rolling contact—effect of gas turbine oils on roller bearing fatigue—effect of lubricants on gear tooth fatigue.

Sessions V & VI. Fluid film lubricated bearings.

Highlights of I. Mech. E. Conference papers on fluid film lubrication—solution of the finite journal and its application to design—self-excited vibrations on air lubricated thrust bearings—use of electric analog field plotter to determine oil flow, film thickness and load carrying capacity—surface deformations in the hydrodynamic slider bearing and their effect on pressure developed.

Corrosion engineers

Papers on protective coatings and application techniques will be given in a 4-paper symposium at the November 12-14 meeting in Pittsburgh of the Northeast region, **National Association of Corrosion Engineers.** Three other papers on coatings will be given in other symposia. Considered will be surface preparation, steam resistant coatings, protection of power plants, evaluation and design factors important in coatings life.

The nuclear field

A new approach to the problem of acquainting engineers in industry with a fundamental understanding of the rapidly growing nuclear field will be offered during four days of talks and discussions in New York in December says **ASME.**

Fat contract

Collins Radio Co. of Canada Ltd. was recently awarded a contract by the Department of Defence Production for the manufacture of UHF airborne transceivers. The contract is valued at $8.3 million.

The RCAF has planned a conversion from VHF to UHF communication for some years.

US buyers

To assist their development project of high-level reconnaissance aircraft, the USAF has recently purchased three airborne profile recorder systems engineered and manufactured by **Canadian Applied Research Ltd.** of Toronto.

Name change

The name of the Diamond State Fibre Co. of Canada Ltd. has been changed to **Continental-Diamond Fibre of Canada Ltd.**

This will achieve closer identity with the Continental-Diamond Fibre Corp., Newark, Delaware (a subsidiary of the Budd Co.). This is the first step in a planned program of expansion and diversification.

Titanium-saver

Startling savings in tools, man hours, and titanium, a metal as precious as silver, have resulted from a new method of preparing its edges developed at the Los Angeles division of **North American Aviation, Inc.** By overcoming the metal's tendency to crack in stretch-forming wherever there are rough edges or shear fractures, the new method has reduced the mortality rate on stretch-forming jobs from as high as 75% to only 1%.

Branch in Canada

General Radio Co. of Cambridge, Mass., manufacturers of electronic apparatus, has opened a factory branch office for Canada at 99 Floral Parkway, Toronto 15.

Mr. Arthur Kingsnorth is in charge of the new office and is assisted by Mr. Richard Brown. General Radio service and repair work will continue to be handled in Canada by Bayly Engineering Ltd. of Ajax.

Ice detector

Wright Air Development Centre at Dayton, Ohio, has placed on its qualified products list the dual probe ice detector engineered and manufactured by **Canadian Applied Research Ltd.** The detector automatically warns the pilot of ice formation long before he can see it or feel it through his controls.

Separate identity

Kee Klamp Division of O'Donnell-Mackie Ltd., formerly operating under Dairy-Brewery Equipment, has now taken on a separate identity in new quarters at 97 Wingold Ave., Toronto 10.

IRE

"Are we educating our engineers for yesterday's jobs?" will be the theme of a panel discussion on engineering education at the 1957 **Institute of Radio Engineers'** Canadian convention-exposition in Toronto, Oct. 16, 17 and 18.

Professor Marcus Long of the University of Toronto will be the speaker at the convention banquet in the King Edward Hotel on Thursday the 17th. His talk is titled "Engineers are people," a timely topic indeed in an age when engineers and machines have come to mean much the same thing in the eyes of a big portion of Mr. Public.

IRE convention-exposition committee. Back row: Clive Eastwood, Grant Smedmor, E. O. Swan, L. C. Simmonds, Frank A. Ford, T. M. Lynd, W. F. Choat, Front row: R. C. Poulter, F. Heath, C. A. Norris, F. H. Pounsett, A. H. Sievert.

NEW GOLDEN BONDERITE for Aluminum

Uniform color means uniform coatings and uniform efficiency

It's the simplest thing in the world to check on the efficiency of a Golden Bonderite installation. Just look at the color of the aluminum as it comes out of the Bonderite machine. The uniform golden coating looks the same—and it is the same—24 hours a day, seven days a week.

Golden Bonderite sets entirely new standards of efficiency and performance as a paint base for aluminum and its alloys. Operated with the Parker "Reactifier," the Golden Bonderite solution can be used indefinitely, ending the costly necessity of dumping the bath at frequent intervals. Normal chemical replenishment keeps the Golden Bonderite solution in continuous balance.

This ease and certainty of achieving uniformly excellent results means real savings for aluminum fabricators.

It guarantees an effective base for paint.

It breaks the finishing line production bottleneck.

It saves money on chemicals.

It saves money on rejected parts and minimizes field calls because of finish failures.

There are no limitations on the use of new Golden Bonderite. It may be applied by spray or immersion. Treatment cycles can be set to suit production speed and equipment.

Samples of Golden Bonderite-treated aluminum, plus test data, are available for your inspection. Write or call.

How Parker "Reactifier" Works

In conventional surface treatments of aluminum, work passing through the solution causes a buildup of impurities. As impurities increase, solution efficiency decreases until there's nothing to do but dump the bath and start over.

The Parker "Reactifier" removes these impurities as fast as they are formed in the Golden Bonderite solution. Constant circulation of the Golden Bonderite through the exclusive "Reactifier" means a balanced, efficient solution that can be used indefinitely.

Write for Bulletin in COLOR!

Get your copy of the descriptive bulletin on Golden Bonderite and its companion, Green Bonderite, for aluminum. It's new!

Since 1914—leader in the field

PARKER RUST PROOF COMPANY OF CANADA LTD.
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BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

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DU PONT CANADA

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

CONVEYOR SYSTEM PERFORMANCE improved by new "ZYTEL" nylon wheels

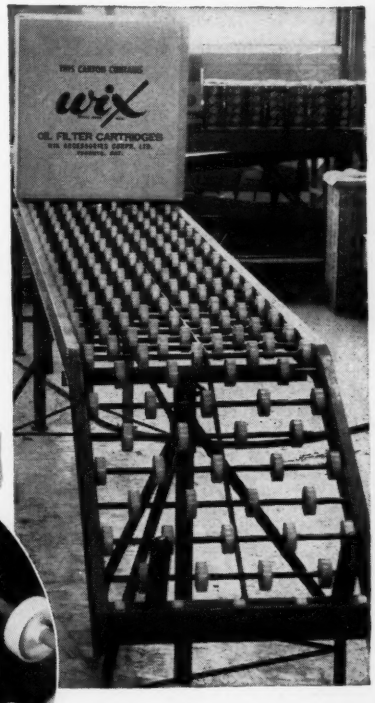
Moulded by **CANADIAN GENERAL ELECTRIC COMPANY**

A new design of conveyor system recently proved itself in test installations. A marked improvement in overall efficiency, together with a substantial reduction in weight, initial cost and upkeep was achieved by using wheels moulded from long-lasting "ZYTEL", the versatile nylon resin developed and produced by DU PONT OF CANADA.

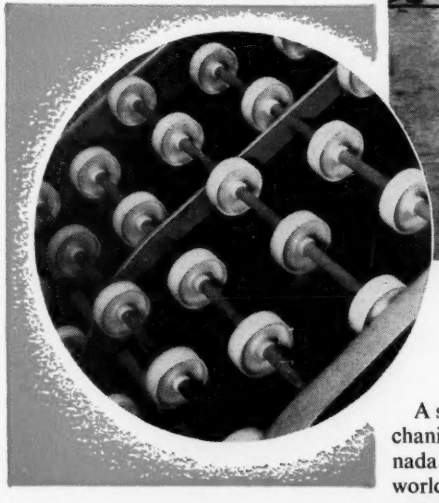
The first experimental installation was made at the Toronto plant of Wix Accessories. The results were such that enthusiastic plant engineers have since ordered four other sections and will eventually have six ten-foot sections in all, installed in their plant.

Certain special properties of DU PONT'S "ZYTEL" nylon resin give it outstanding advantages over metal as an efficient, economical, long-lasting material for conveyor system wheels.

1. Due to its exceptional lightness — less than 1/2 the weight of aluminum and 1/7 that of steel — "ZYTEL" nylon resin provides a definite advantage for use in portable type conveyors in particular.
2. Considerably less expensive than aluminum wheels, those made of "ZYTEL" also cost somewhat less than steel wheels.
3. Strong and durable, the wheels in this installation were designed for loads up to 65 lbs. per sq. inch. Wheels could be made from "ZYTEL" for any light or medium duty installation.
4. Unlike metal wheels, "ZYTEL" nylon wheels require no lubrication, yet wear less over a given period of time.
5. The complete resistance of "ZYTEL" nylon to corrosion is an especially important factor in the fisheries market and food packaging industry where, in the former, salt water is always present and, in the latter, water and corrosive solvents are employed to wash down conveyor assemblies.



The Wix Accessories installations — as well as others made by some Canadian firms to date — feature conveyor assemblies designed and produced by the Specialty Manufacturing and Distributing Co. of Toronto, with wheels moulded from Du Pont's "ZYTEL" nylon resin by the Canadian General Electric Company of Cobourg, Ont.



A steadily increasing number of mechanical parts are being made in Canada from "ZYTEL" nylon resin—the world's outstanding new engineering material. It is quite probable that you too could realize savings through its use. Why not give your moulder a call and ask him or, if you wish, contact us. We will be glad to provide you with information and recommendations.

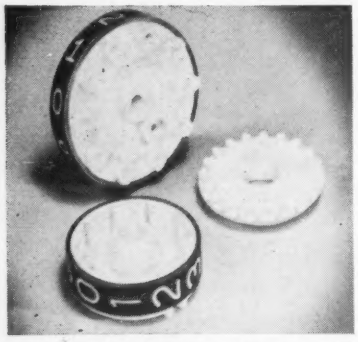
OVER

DU PONT CANADA

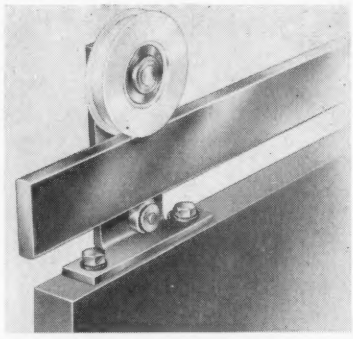
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON DU PONT "ZYTEL" NYLON RESIN

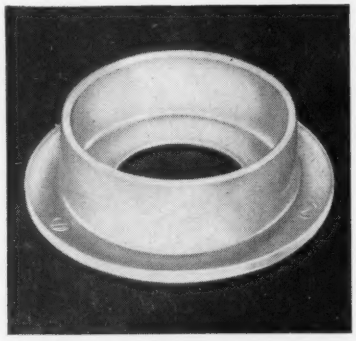
18 product



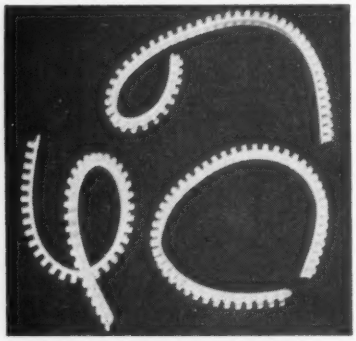
These counter wheels are molded in two different colors from ZYTEL. Light in weight, ZYTEL enables faster movement of the wheels with less power and a minimum of noise. (Manufactured by Electric Manufacturing Co., Inc., San Francisco, California.)



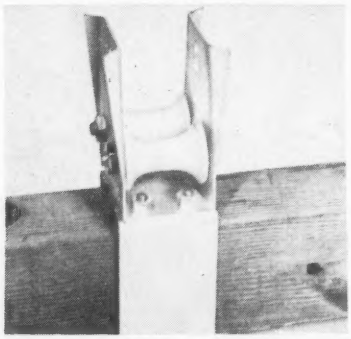
Hangers for horizontal sliding elevator doors require a high degree of rugged construction combined with extreme operating ease. The "ZYTEL" nylon molding for these wheels was done for Turnbull Elevator by Toronto Plastics Limited, Toronto, Ontario.



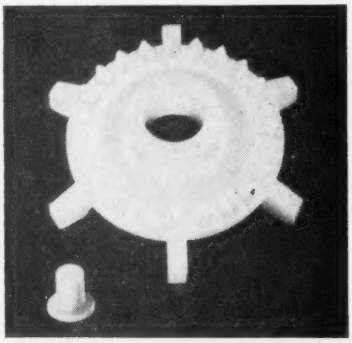
Simple nylon molding gives better seal, longer life and simplifies assembly of famous "Wix" oil filter cartridges. Required to remain tight at temperatures ranging from 50 below zero to 200 above, these seals were molded by Smith and Stone Limited, Toronto 5, Ontario.



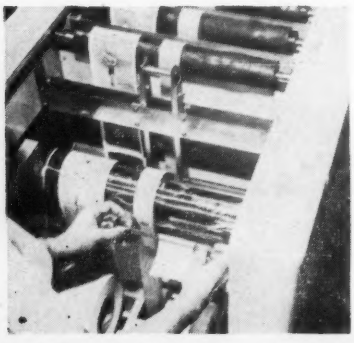
Grommets of ZYTEL are flexible and strong in thin sections—protect wire insulation from chafing in eyelets of any size or contour. These grommets are quickly cut and fitted from a 10-inch "Caterpillar" strip. (Manufactured by Nylon Molding Corporation, Garwood, N. J.)



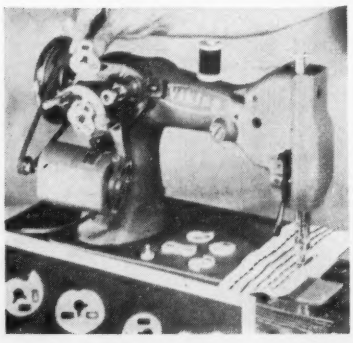
Cable stringing block is equipped with spools of ZYTEL which are abrasion-resistant and tough—will not damage cables. (Processed by Engineered Products, Inc., Kirkwood, Missouri for D. H. S. Company, St. Louis 17, Missouri.)



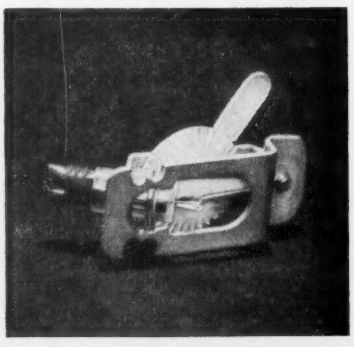
Oil slinger gear of wear-resistant ZYTEL operates quietly and withstands high temperatures inside an air-cooled engine. Stop switch button of ZYTEL stays cool even when engine is at 200° F. (Molded for Briggs and Stratton Corp., by Sinko Mfg. & Tool Co., Chicago.)



The belting of this photo processing machine is made of ZYTEL—is unaffected by developing and cleaning solutions. ZYTEL has high tensile strength, even in thin sections, and is resilient and flexible. (Belting produced by The Polymer Corporation of Pennsylvania, Reading, Pennsylvania.)

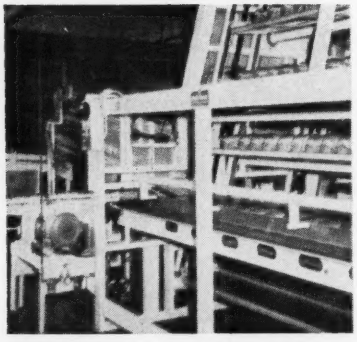


Interchangeable cams of ZYTEL in this sewing machine provide variations in stitching patterns. ZYTEL simplifies production, lowers costs due to ease of molding. (Molded by Boonton Molding Company, Boonton, New Jersey, for Consolidated Sewing Machine Corporation, New York, New York.)

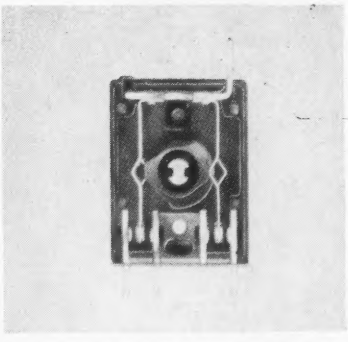


Phonograph needle holder of ZYTEL is molded into intricate shape and holds switching mechanism for different speed needles. Important in this application are the good dielectric properties and toughness of ZYTEL. (Phonograph needle holder manufactured by Electro-Voice, Buchanan, Michigan.)

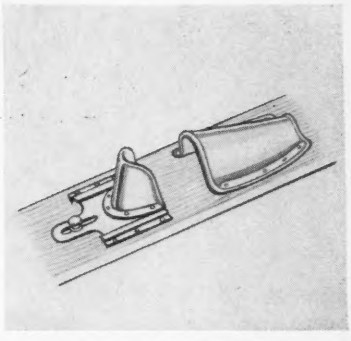
examples of improved design with "ZYTEL" nylon resin



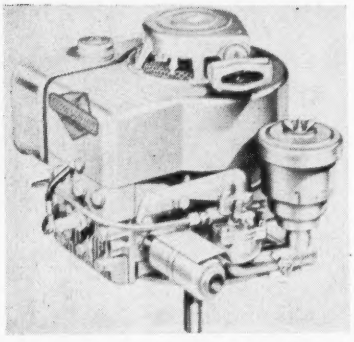
The rollers of this bread cooling equipment are manufactured under the Sanitation Code. Over-all performance of ZYTEL is found superior to that of metal. (Molded by United Plastics Industries Inc., Vassar, Michigan. for Baker Perkins Inc., Saginaw, Michigan.)



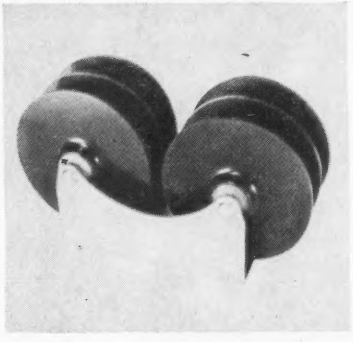
The cams which control the indexing of this rotary switch are made of ZYTEL. Because of its durability and strength qualities, ZYTEL replaced another material. (Molded for Cutler-Hammer Inc., by Sinko Mfg. & Tool Co., Chicago, Illinois.)



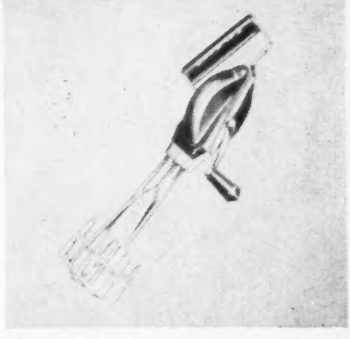
The "Brydon Boy" B-110 ski harness uses "ZYTEL" nylon clips where the maximum stress is experienced in water skiing. Replacing aluminum stampings formerly used to anchor the soft, flexible toe and heel pieces, these "clips" were molded for Brydon Brass Mfg. Co. Ltd. of Toronto by Toronto Plastics Limited, Toronto.



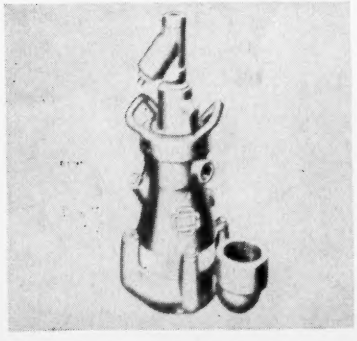
The bumpers for the starter pulley of this engine are made of ZYTEL, are adaptable to mass production. Quiet operation and longer wear result, because ZYTEL requires little or no lubrication. (Engine produced by Briggs and Stratton Corporation, Milwaukee, Wis.)



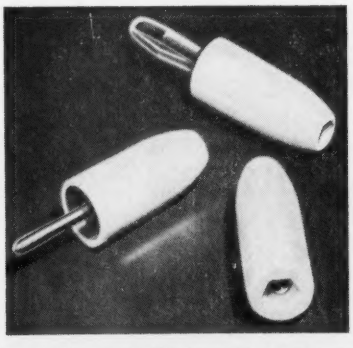
Bushings in a new sealed journal box KIT are made from ZYTEL. Important in this railroading advancement is the ability of ZYTEL to withstand extremes in temperature. (Manufactured by National Motor Bearing Company, Inc., Redwood City, California.)



The gears, bearings and blades of this mixer are made of ZYTEL because it is light in weight and resistant to heat, wear and corrosion. The Maynard Manufacturing Company of Glendale, California, expects these parts made of ZYTEL to outlast useful mixer life.



This pneumatic sump pump, run by air pressure, contains four vanes of ZYTEL. Driven at high speeds, the vanes are resistant to wear and are molded to extremely close tolerances. (Molded by Ingwersen Manufacturing Co., Inc., Denver, Colorado, for Gardner-Denver Company, Denver, Colorado.)



Tip jacks of ZYTEL have high dielectric strength, resist heat, cold and moisture, and stand up to high voltages under rugged operating conditions. Threaded insulating sleeve of ZYTEL with standard tip jack provides superior connector. (Manufactured by E. F. Johnson Company, Waseca, Minnesota.)

The latch on this window assures long-time service, because of the toughness, abrasion-resistance and high-impact strength of ZYTEL. (Molded by DuBois Plastic Products, Inc., Buffalo, N.Y., for Curtis Companies, Inc., Clinton, Iowa.)

OVER

DU PONT CANADA

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

New Canadian Plant now producing "ZYTEL" nylon resin

A new concept in plastics utilization is "home-grown" for Canadian industry.

The days of "plastic substitutes" have passed into history. The possibility of precise mechanical design using a plastic material is now a reality — thanks to 2 years of research and testing by Du Pont.

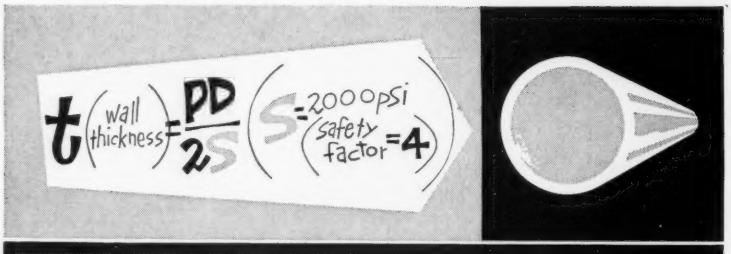
It took a remarkable material, "Zytel" nylon resin, to make the effort worthwhile.

"Zytel" nylon, plus good design and competent fabrication offers many cost-saving possibilities. These are brought about through lower initial costs and better performance of many mechanical parts in machines, hardware, appliances — even in notions, novelties and housewares. These possibilities should be of considerable importance to Canadian manufacturers faced with finding lower costs and better merchandise to meet the stiff competition of today.

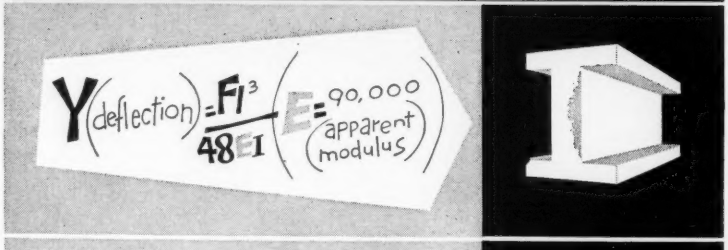
Because of this, Du Pont Company of Canada (1956) Limited has installed and is operating a plant at Kingston, Ontario to make this useful material for the Canadian market.

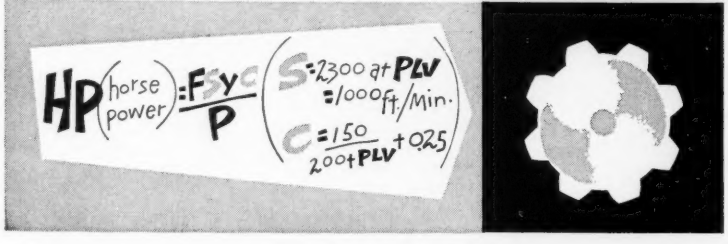
Actually, we do more than just make the resin. We also extend assistance to engineers and designers, to help them utilize the properties of "Zytel" to advantage, and of course, we assist molders in establishing optimum operating conditions required to faithfully reproduce the properties of the material in finished parts. In short, we provide a touch of creative imagination backed by sound technical knowledge along with a product of proven value.

There are several well-qualified Canadian molders who can help you to get these new values for your product. Why not let them — and us — have a chance to see what we can do for you?



"ZYTEL"- The Versatile Answer to Many Engineering Problems





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DU PONT COMPANY OF CANADA (1956) LIMITED,
CHEMICALS DEPARTMENT, P.O. Box 660, Room A-4, MONTREAL, QUE. DE-10

Please send me more information on the Du Pont plastic engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *Lucite". I am interested in evaluating these materials for*

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COMPANY _____

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CITY _____ PROVINCE _____

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*"Alathon", "Lucite" and "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

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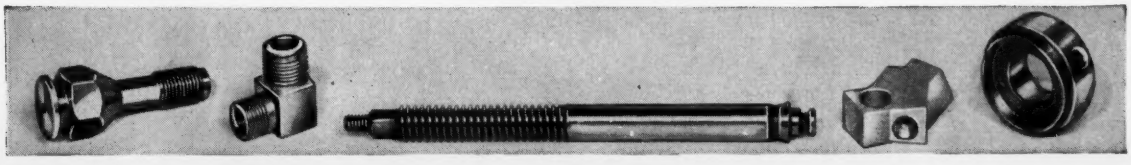

The designer: "Lends itself more readily to modern, functional styling."
The sales manager: "Satincoat leads to easier sales. Customers know steel stands up over the years."
The cost accountant: "Cuts manufacturing costs without sacrificing quality or lasting beauty."
The production manager: "Steps up production by eliminating need for dipping after fabrication, or priming before painting."

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for versatile low-cost fabrication...

Satincoat is a new, zinc-coated steel that provides every advantage of imported electro-galvanized steel but at far less cost! Manufactured in Canada by the continuous galvanizing process, *satincoat's* protective zinc coat remains uniform during fabrication. Will not crack or peel to expose base metal. Takes paints, lacquers or enamels without costly priming or risk of underfilm corrosion.

For more information on the cost-cutting properties of *satincoat* . . . and the contribution it can make to the good name of your products . . . *see your steel distributor*, or write to

DOMINION FOUNDRIES AND STEEL, LIMITED
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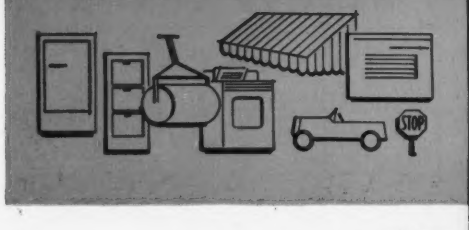
For better products at lower cost . . .



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With 'Instruments' too — experience is what makes the difference

Taste a dish prepared by a great chef; ask him to give you the recipe and to tell you exactly how he makes it . . . then — following his instructions — prepare the dish yourself. You notice the difference? Well, after all, you would expect to.

The odd thing is that, with the best will in the world, the chef cannot tell you what he does that makes the difference. It is even more odd that something similar can happen with an engineering Company that has been in business for a long time. This is because the solutions to many of the problems that arise in the manufacture of an instrument are supplied by the experience and knowledge you cannot find in text books. This is why, even in these days of standardisation, a name with a long history still counts for something.

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Design for

SIMPLIFIED ASSEMBLY

replace multiple parts

with a single polyester molding

In a circuit breaker contact assembly, the large ATLAC THERMAFLOW molding shown here replaces three smaller parts. Molded-in busbars end alignment problems...20 bolts are eliminated from assembly operations. High-strength ATLAC THERMAFLOW 2400 compound permits thinner cross-section, reduces overall size. Molded for General Electric Switchgear Division by Penn Plastics Co., Glenside, Pa.

You can cut assembly costs, reduce need for fastening hardware, and meet close tolerances readily . . . by designing with ATLAC THERMAFLOW reinforced polyester molding compounds. Metal bushings and fittings can be molded in place, to give simple, one-piece construction. You can combine several pieces into a single ATLAC THERMAFLOW molding, because these high strength materials give structural rigidity and ruggedness in large shapes . . . and they're easily molded into complex forms.

In addition, ATLAC THERMAFLOW materials offer:

- **Excellent electrical properties: insulation resistance**
- **and arc tracking resistance**
- **Weight savings: specific gravity 1.8**
- **High impact and flexural strength**
- **Superior corrosion resistance**
  Good surface finish . . . no machining needed
- **Variety of attractive colors; paint, if desired, without bonding coat**

ATLAC THERMAFLOW materials can be compression or transfer molded on standard presses, at temperatures from 275 to 350°F, and pressures from 400 to 900 psi. They can be molded readily in shapes with deep draw and intricate detail. Curing time is relatively short.

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ATLAC THERMAFLOW

ATLAS POWDER COMPANY, CANADA, LTD.
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***Offices in* MONTREAL, TORONTO, EDMONTON, VANCOUVER**

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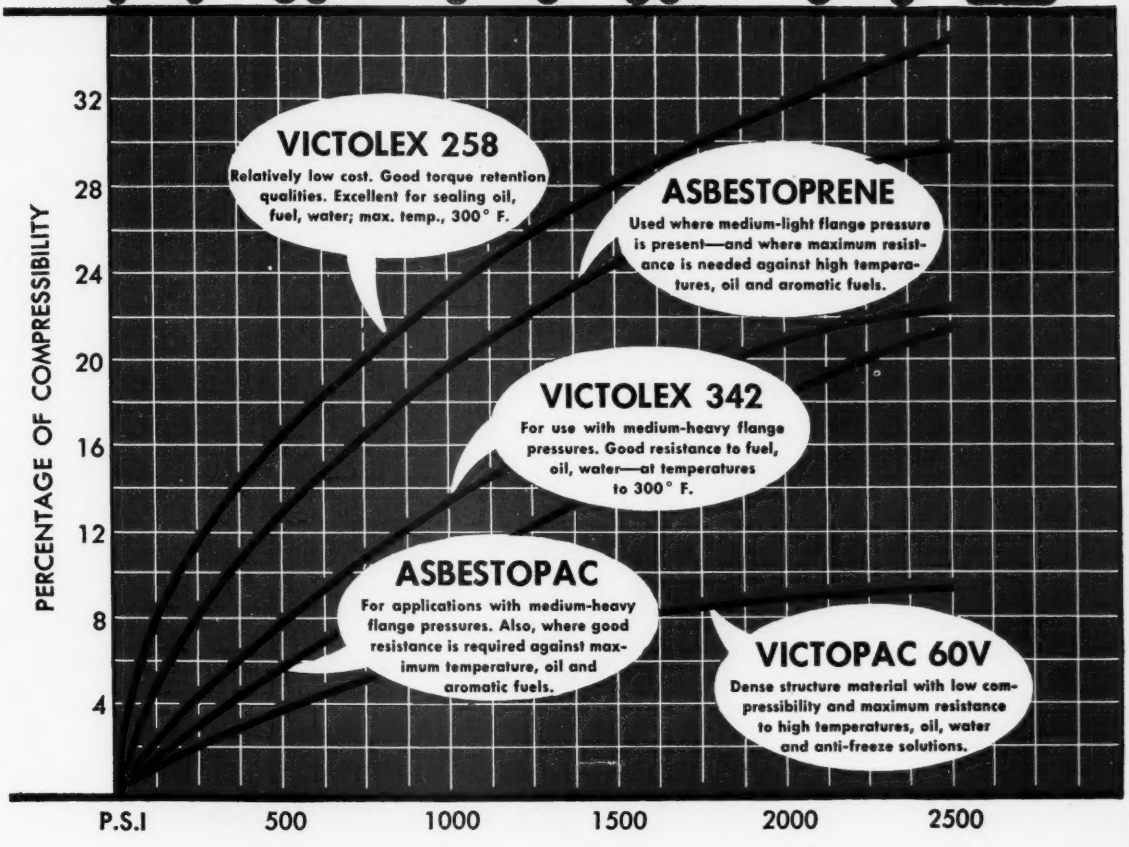
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Relatively low cost. Good torque retention qualities. Excellent for sealing oil, fuel, water; max. temp., 300° F.
ASBESTOPRENE
Used where medium-light flange pressure is present—and where maximum resistance is needed against high temperatures, oil and aromatic fuels.
VICTOLEX 342
For use with medium-heavy flange pressures. Good resistance to fuel, oil, water—at temperatures to 300° F.
ASBESTOPAC
For applications with medium-heavy flange pressures. Also, where good resistance is required against maximum temperature, oil and aromatic fuels.
VICTOPAC 60V
Dense structure material with low compressibility and maximum resistance to high temperatures, oil, water and anti-freeze solutions.
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If you do not know where to reach him, write Victor Mfg. & Gasket Co., of Canada Ltd., St. Thomas, Ont. In U.S.—Victor Mfg. & Gasket Co., P. O. Box 1333, Chicago 90, Ill.

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Write for Bulletin 114F which illustrates and gives engineering data on smaller size Clevelands—many now available for immediate delivery. Peacock Brothers Limited, P. O. Box 1040, Montreal 3, Que. Branch offices in Sydney, Toronto, Sudbury, Winnipeg, Edmonton, Calgary and Vancouver.

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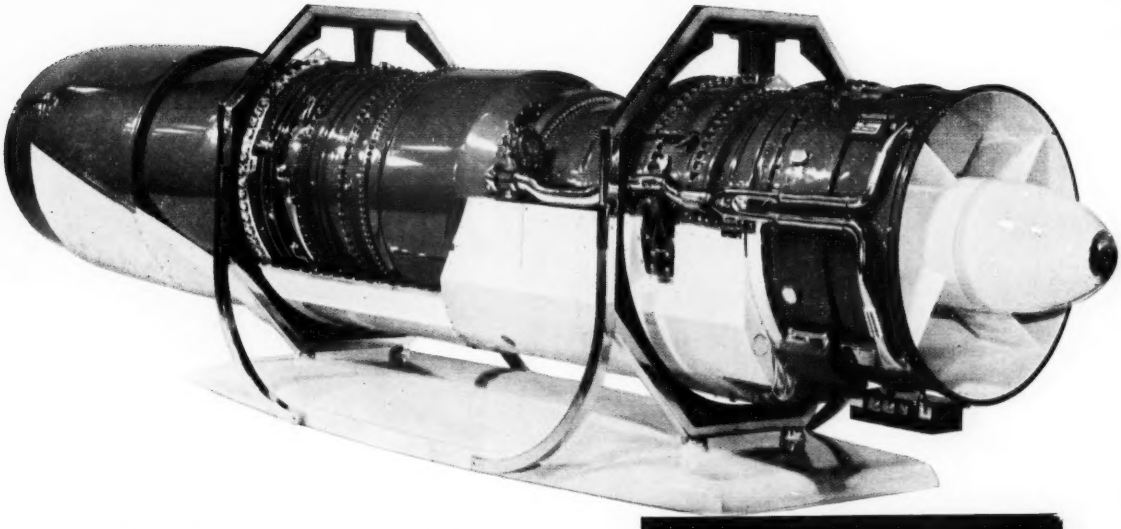
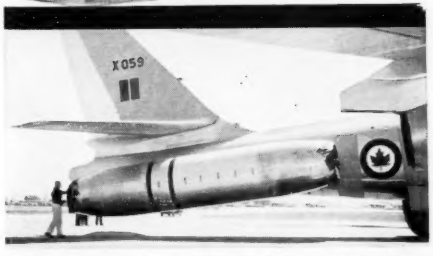


The Iroquois designed, developed and produced by Canadians is the supersonic successor to the Orenda jet engine, 4,000 of which are in service on four continents.



FLIGHT TESTING THE NEW IROQUOIS AT MALTON
The supersonic Iroquois is carried in this specially designed pod at the rear of a B-47.

ORENDA ENGINES LIMITED

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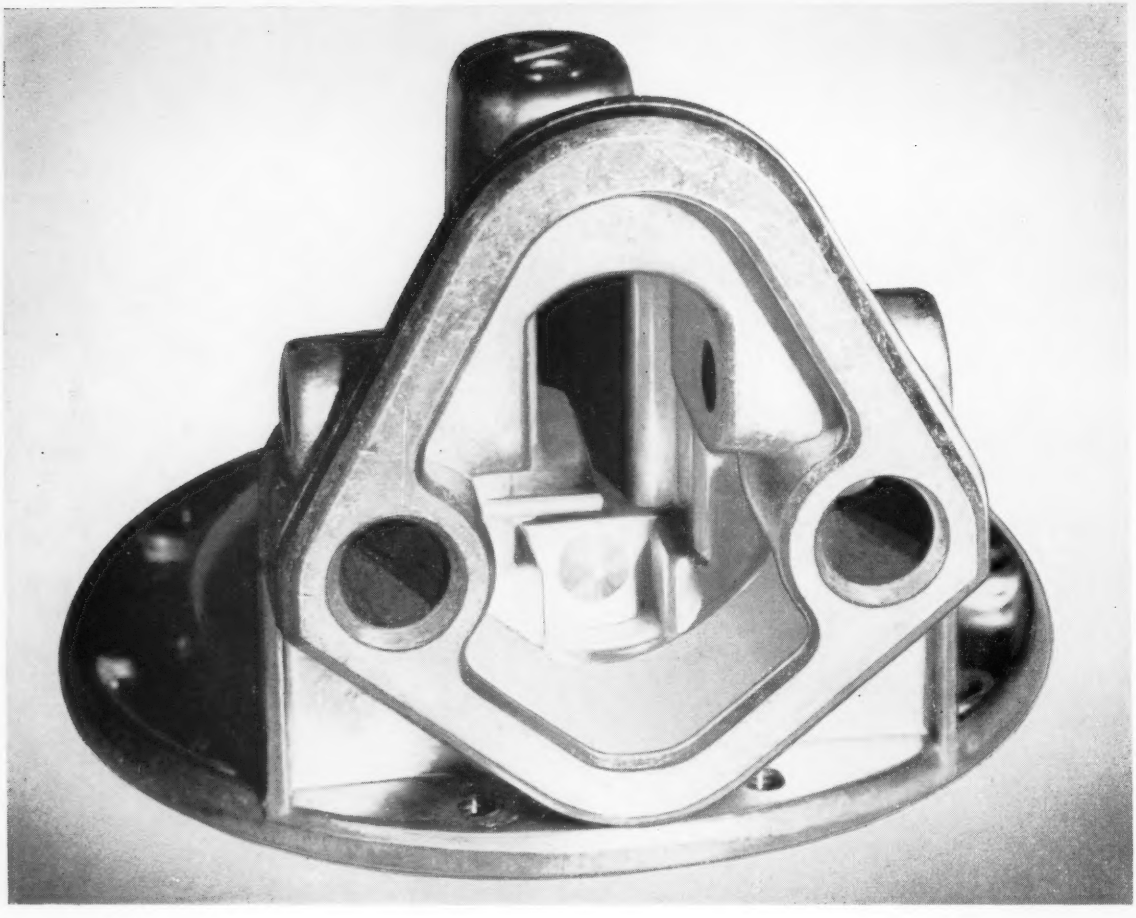

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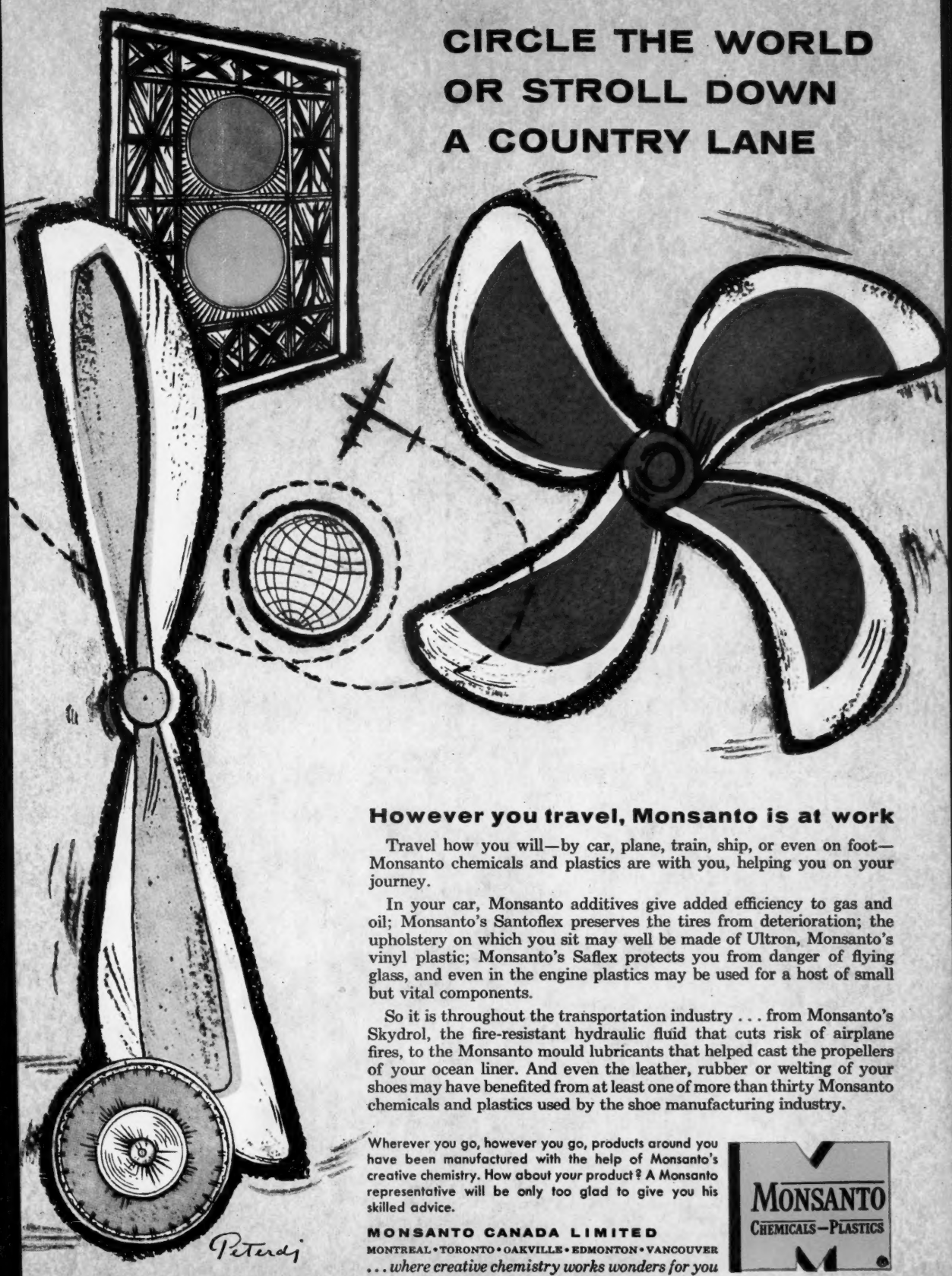

However you travel, Monsanto is at work

Travel how you will—by car, plane, train, ship, or even on foot—Monsanto chemicals and plastics are with you, helping you on your journey.

In your car, Monsanto additives give added efficiency to gas and oil; Monsanto's Santoflex preserves the tires from deterioration; the upholstery on which you sit may well be made of Ultron, Monsanto's vinyl plastic; Monsanto's Saflex protects you from danger of flying glass, and even in the engine plastics may be used for a host of small but vital components.

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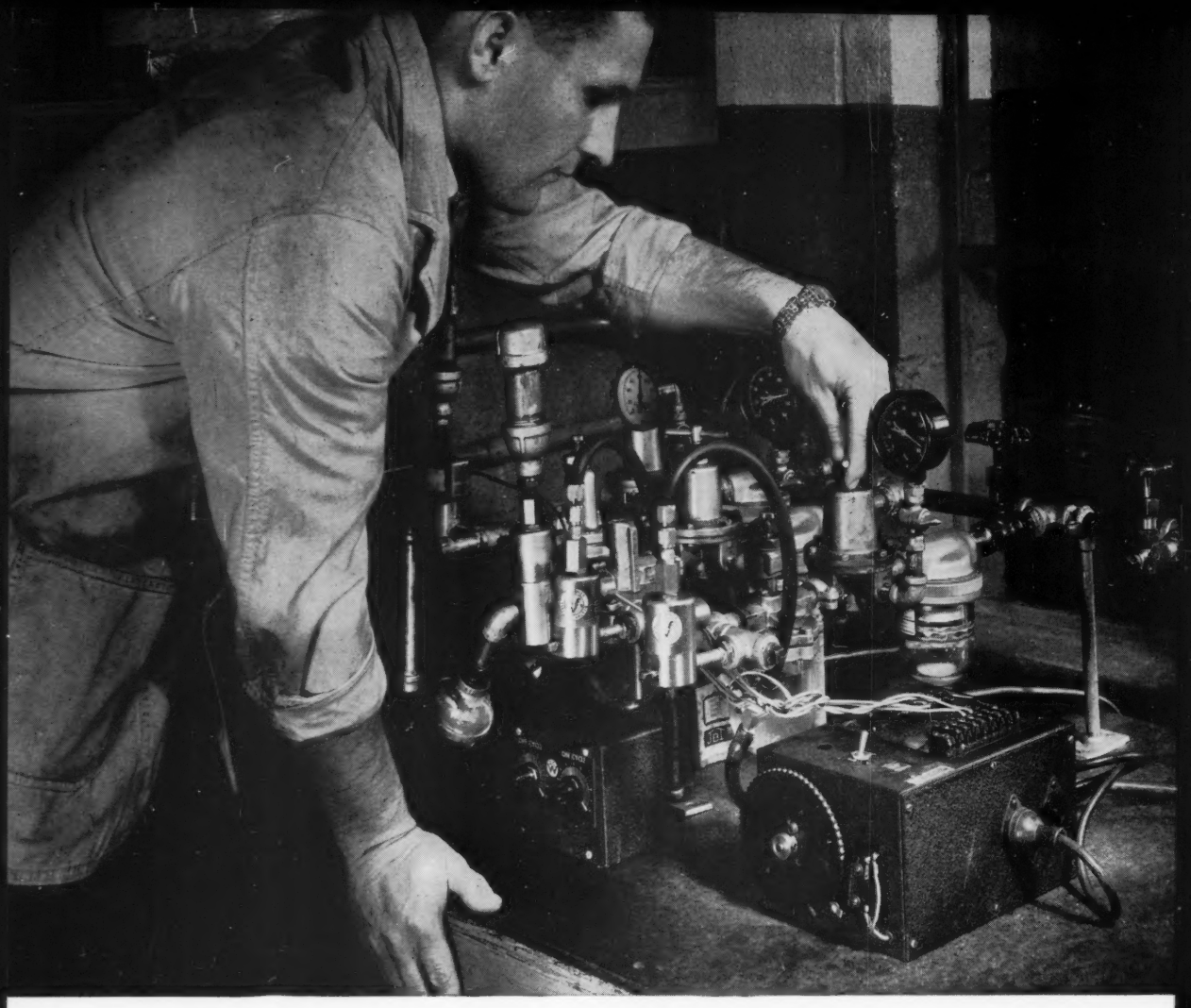

You can expect extremely long life from Skinner Solenoid Valves. Here's why...

In the lab shown above, dozens of Skinner valves are life-cycled 24 hours a day, 7 days a week, at speeds as high as 600 cycles per minute. It is here that we try out new designs, new materials, new construction methods. It is here that we test the stability of our welded joints . . . the resistance to burnout of our coils . . . the effectiveness of our positive spring returns . . . the better seal we obtain by eliminating packings. And it is here we find positive proof of Skinner valves getting over 20,000,000 cycles without leakage.

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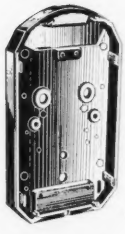
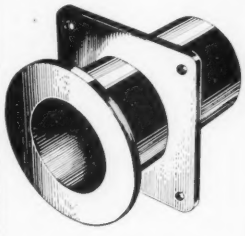
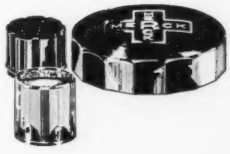


TELEPHONE BASE
—for moldability, machineability, strength



TRANSFORMER PART
—for dielectric properties and dimensional stability

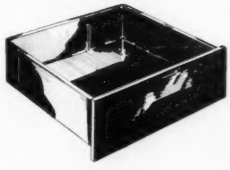
IRON HANDLE AND DIALS
—for heat resistance, appearance



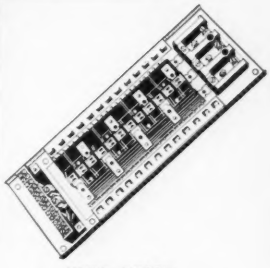
CONTAINER CAPS
—for strength and appearance

DISTRIBUTOR CAP
—for moldability and dielectric properties

TELEPHONE RECEIVER
—for strength, moldability, appearance



FURNITURE DRAWER
—for moldability and strength



PANEL BOARD
—for dielectric properties, dimensional stability

Check these properties for your component parts:

- ★ **MOLDABILITY**
- ★ **MACHINEABILITY**
- ★ **DIMENSIONAL STABILITY**
- ★ **HEAT RESISTANCE**
- ★ **APPEARANCE**

All these products have one thing in common—the "Bakelite" phenolics plastic from which they are made.

In each case the plastic has been chosen for a particular purpose—to provide electrical insulation, close tolerances, resist heat, water or chemicals, machineability, and adaptable to intricate shapes. Besides these properties, the component part must retain its serviceable good looks indefinitely.

We suggest you investigate—could your product look better, perform better, and last longer made of quality "Bakelite" phenolic materials?

Write for a list of phenolic plastic molders in Canada.

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"Bakelite" and "Union Carbide" are trade marks

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That's why for today's high horsepower engines, White and others depend upon Blood Brothers Propeller Shafts.

If you have a propeller shaft problem, look to Blood Brothers. Our engineering department will be happy to make suggestions.

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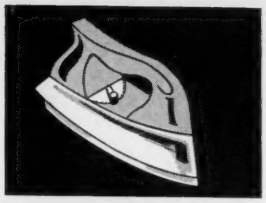

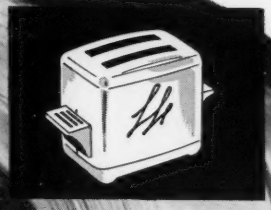

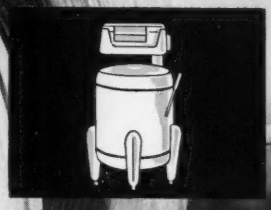

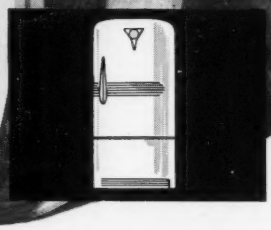

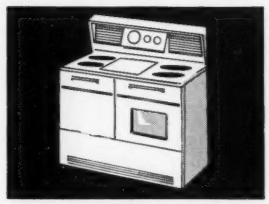

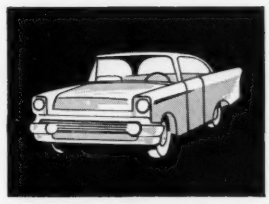

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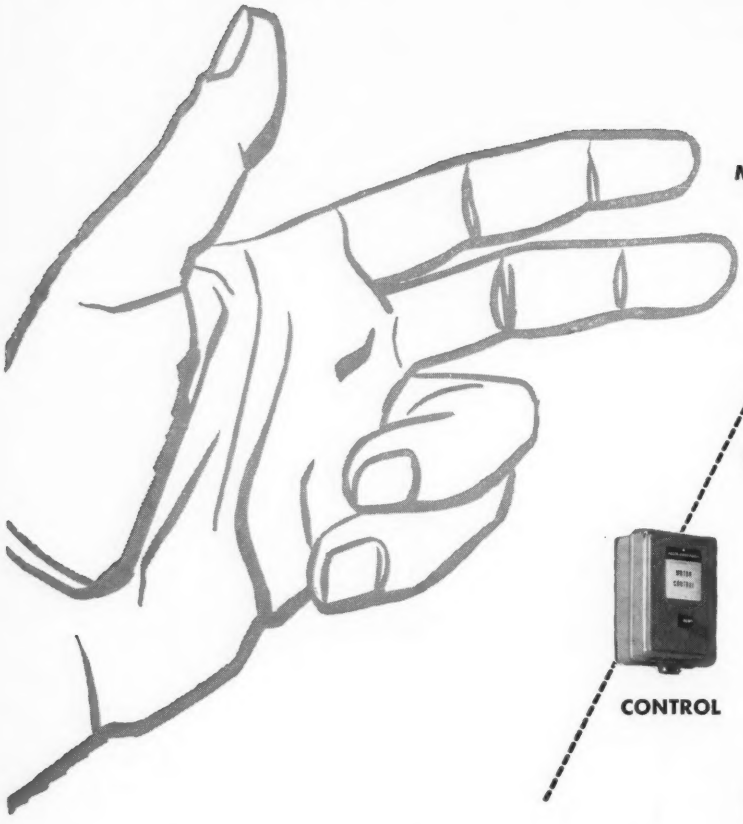
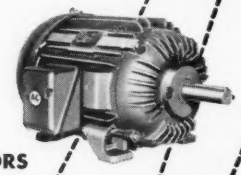
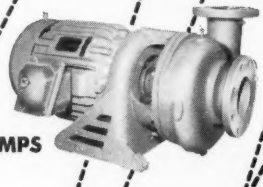


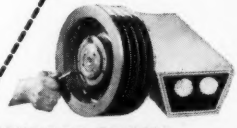


MOTORS



PUMPS

CONTROL



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Something extra goes into the full line of Allis-Chalmers control, motors, pumps and *Texrope* drive equipment. We call it "quality-craftsmanship." It means long-run dependability; it means the real cost of A-C products stays low.

Find out more from your Allis-Chalmers office or write Canadian Allis-Chalmers Ltd., P.O. Box 37, Montreal, Que.

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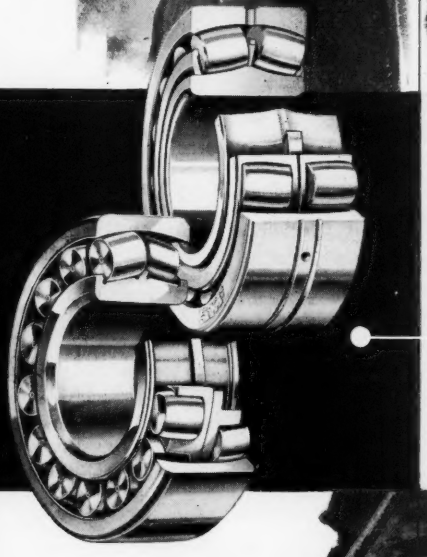

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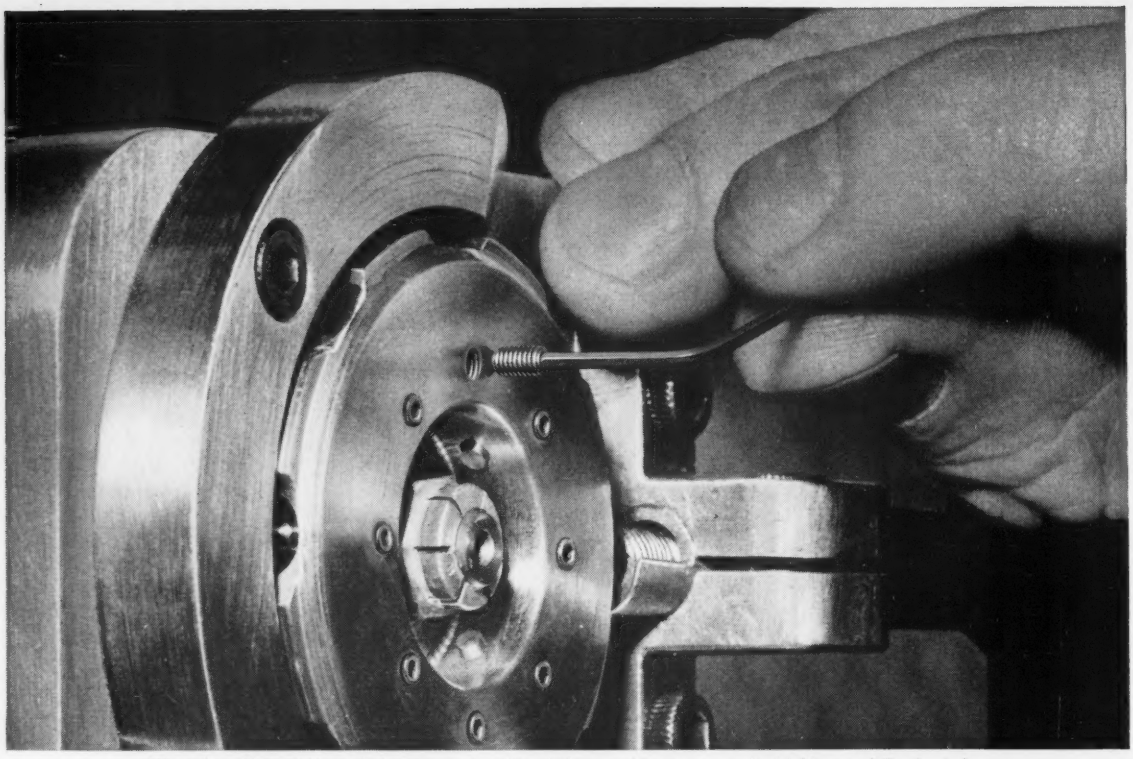


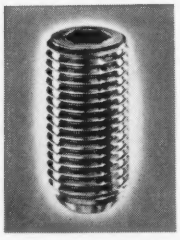
Microsize UNBRAKO socket screws simplify design problems—even in highly specialized equipment like this prototype precision loading device for use in advanced automated production operations.

Miniaturize with UNBRAKO set screws

HEAT-TREATED ALLOY STEEL*
PLAIN CUP POINT
Class 3 Fit Standard

Diameter	Threads per inch NC	Threads per inch NF	L Overall Length	Recommended Installation Torque in Inch-Pounds NC	Recommended Installation Torque in Inch-Pounds NF	Weight per Box of 100 in Pounds
	..	80	1/16	..	.5	.01
	..	80	3/32	..	.5	.01
#0 D .060 F .028	..	80	1/8	..	.5	.01
	..	80	5/32	..	.5	.01
	..	80	3/16	..	.5	.01
	..	80	1/4	..	.5	.01
	..	72	1/16	..	1.5	.02
	..	72	3/32	..	1.5	.02
#1 D .073 F .035	..	72	1/8	..	1.5	.02
	..	72	5/32	..	1.5	.02
	..	72	3/16	..	1.5	.02
	..	72	1/4	..	1.5	.02
	56	..	1/16	1.5	..	.03
	56	..	3/32	1.5	..	.03
#2 D .086 F .035	56	..	1/8	1.5	..	.03
	56	..	5/32	1.5	..	.03
	56	..	3/16	1.5	..	.03
	56	..	1/4	1.5	..	.03
	48	..	3/32	5.0	..	.04
#3 D .099 F .050	48	..	1/8	5.0	..	.04
	48	..	5/32	5.0	..	.04
	48	..	3/16	5.0	..	.04
	48	..	1/4	5.0	..	.04

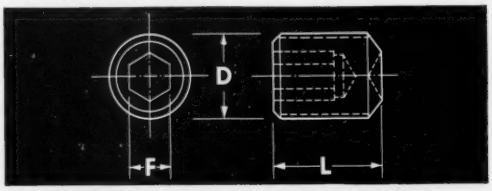
*Also available in stainless steel



You need not design special set screws to secure your new miniaturized equipment. Microsize UNBRAKOs were developed specifically for use in modern small devices.

UNBRAKO screws are made of carefully selected alloy steel. They are manufactured to timepiece precision. Sockets are deep and uniform for greatest wrench engagement and longest reuse. Threads are fully formed for maximum strength and exact fit. And UNBRAKOs are heat treated to the optimum condition for high tensile strength and ductility without brittleness or decarburization.

Ask your authorized industrial distributor about microsize UNBRAKO socket screws today. Or write us for Bulletin 1001 and samples.



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Here at last is a versatile tool... rugged and wide-ranging in its application to production line and on-the-spot electrical connector installations. Additional convenience features include—rotatable control lever for easy operation in a variety of positions — compact alligator jaws — positive die set alignment — and many more. Air pressures from 80 to 125 lbs. psi provide instantaneous connections.

For complete details, write

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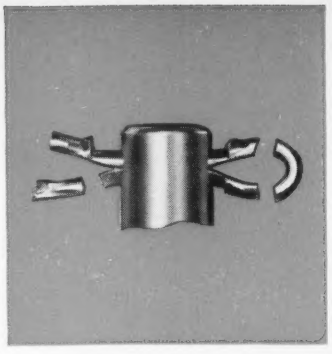
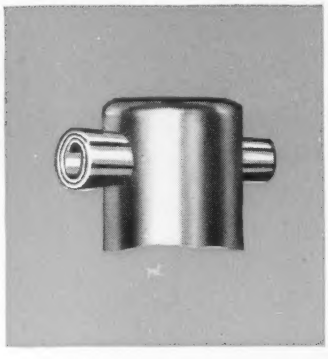
Spirol Pins in Morse Roller Chain resist vibration, absorb shock.



Standard heat-treated cotter pin fails after only 3 hours on fatigue tester. Failure in use means costly downtime.



Spirol Pin shows no sign of fatigue after 50 hours on tester. And it won't shake out or break off like cotter pins.

Another Morse advantage for Canadian users . . .

SPIROL PIN FASTENERS AT NO EXTRA COST . . . A MORSE ROLLER CHAIN EXCLUSIVE

Spirol Pins outlast any other fastener on the market! And they are now featured on Morse Roller Chain at no extra cost.

Spirol Pins resist vibration and shock—won't shake loose or break. These stronger fasteners cut down-time.

Spirol Pins are interchangeable with cotter pins on all Morse Roller Chain now in use. They are easy to install—require no special tools.

Morse Roller Chain has longer service life built in. Specially treated, precision-finished steel parts withstand shock and fatigue . . . reduce operating and maintenance costs.

These are the reasons you can depend upon Morse Roller Chain. So, call your Morse Distributor today for *all* your power transmission needs. His name is listed in the Yellow Pages of your telephone directory. Or write: *Morse Chain of Canada, Ltd., Simcoe, Ontario.*

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

MORSE*

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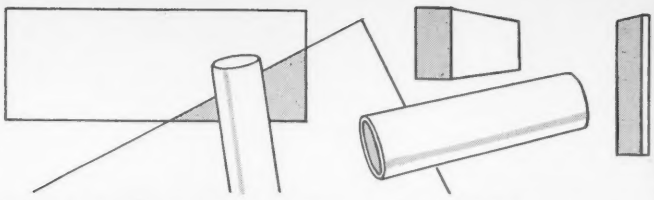

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Nylon strips and slabs
Polyethylene slugs

MOULDING POWDER
Plexiglas V — high heat resistant
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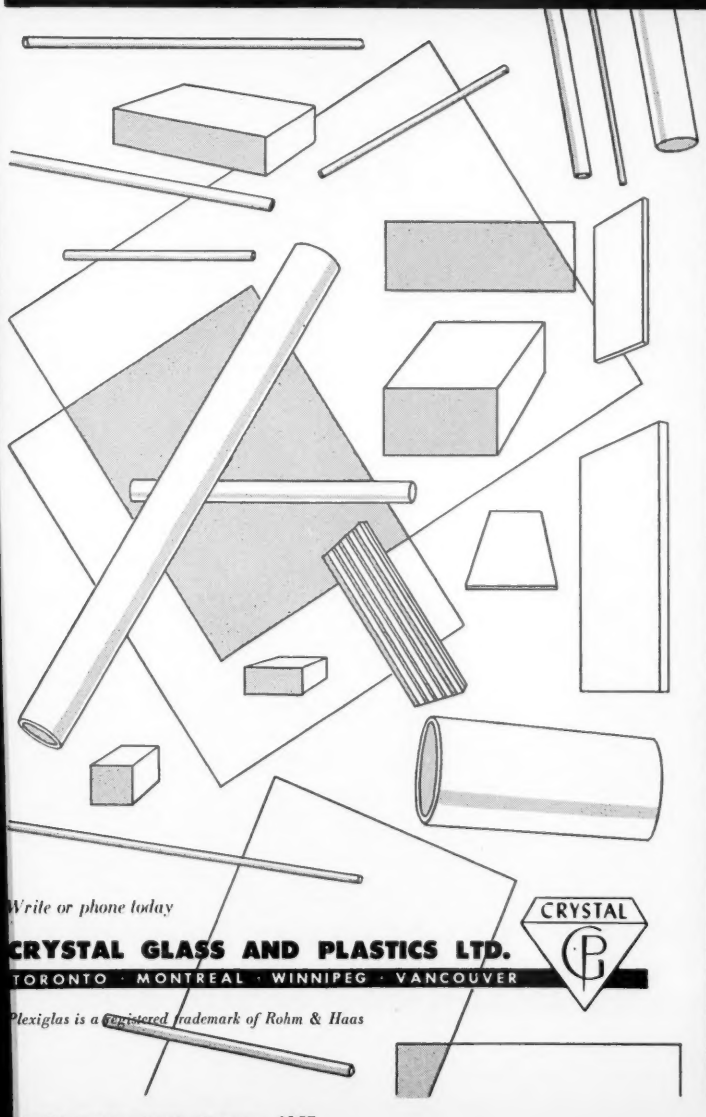

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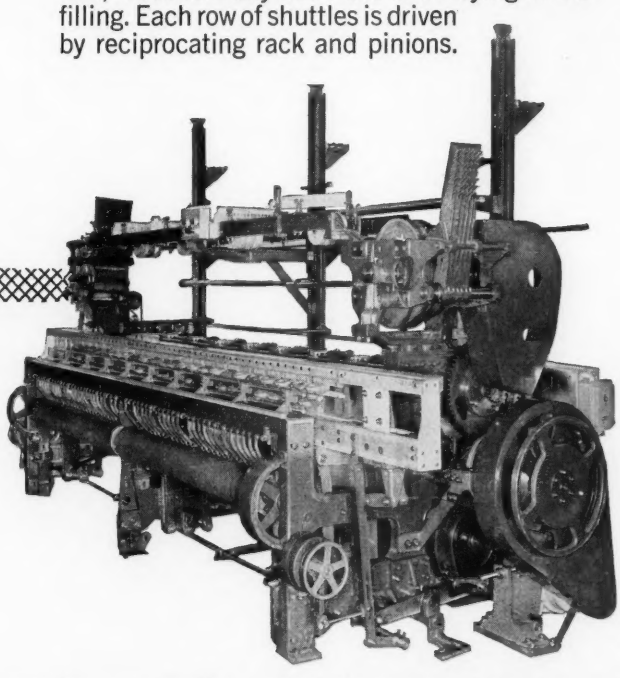
HEIM *Unibal*

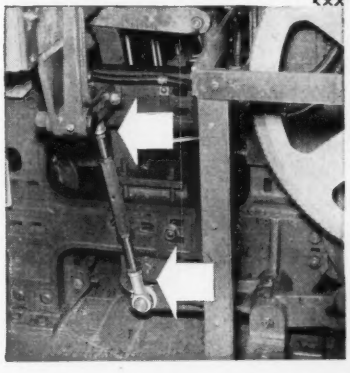
spherical bearing rod ends

In the production of narrow fabrics, the lay on the Crompton & Knowles Narrow Fabric Loom is driven back and forth from front to back, and the shuttles, arranged in two rows, top and bottom, move laterally back and forth laying in the filling. Each row of shuttles is driven by reciprocating rack and pinions.



are Necessary

To take care of inherent misalignments due to the backward and forward motion of the lay, and the lateral motion of the rack rods, **it is necessary to use HEIM Unibal Rod Ends.**



Correcting operating misalignment is just one indispensable feature of Heim Unibal. They have a greater surface supporting area, and are able to carry heavier axial and thrust loads. They reduce friction and lost motion, and eliminate brinelling. They are economical to buy, easy to install, and have a wide variety of uses.

THE HEIM COMPANY
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Be sure you have the Heim Catalog showing sizes and load ratings

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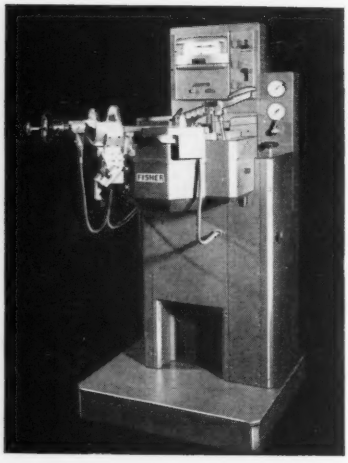
Welded Design

ADDS TO APPEARANCE AND STRENGTH

. . . CUTS COST

(Below) Original die casting machine made by Fisher Gauge Works, Peterborough, Ont.



NEW

NEW

NEW

New welded design (right) eliminates bar framework—**reduces number of component parts by 50%.**

Above are the "before and after" pictures of this compact die casting machine—see how redesign in welded plate has smoothed off surfaces, added rigidity and strength.

Sturdiness was a must — to provide greater protection for delicate instruments and to dispense with the need for bolting the machine to the operating floor.

Today, designers are alive to the advantages of welded steel construction over other methods — including casting. It saves time and materials . . . makes stronger, longer - lasting products . . . and provides many production short-cuts.

LINCOLN can help you with welded design

The new 11th edition Welding Procedure Handbook, available from Lincoln at cost will be a valuable addition to your technical library.

Ask for particulars of Lincoln's Weldesign Course arranged especially for Designers.

Write for your free copy of "Elements of WELDesign" — a guide to better products at lower cost. Issued quarterly.

Ask for a Lincoln representative to assist in conversion to welded design.

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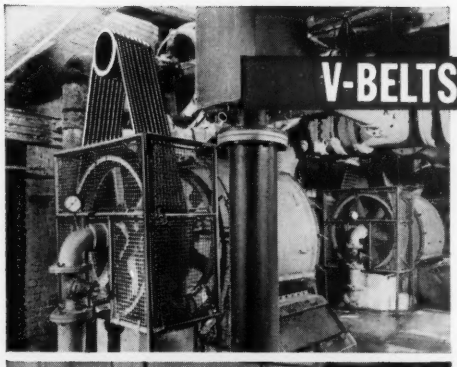
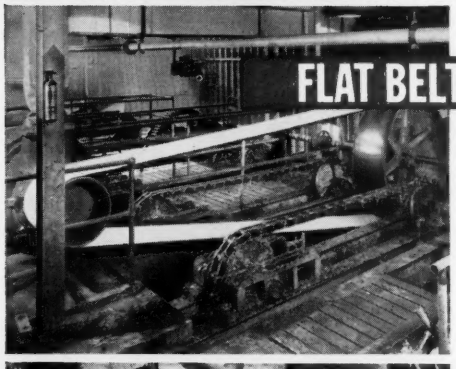
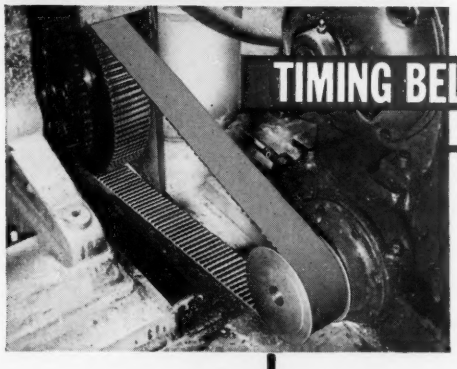
MORE Zip IN POWER TRANSMISSION





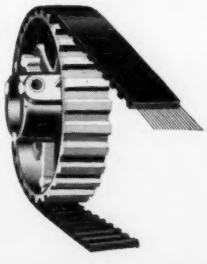


No matter what your power transmission requirements may be, Dominion Rubber can fill them—and give new *zip* and *zing* to your machine. You can always depend on immediate service and shipment, because Dominion Rubber distributors and warehouses are conveniently located in the principal cities of Canada.

The Dominion transmission belt line includes flat belts, V-belts and complete Power Grip Timing Belt drives, *leaders* in every category. Dominion engineers will explore and evaluate your needs for any specialized drives.

Another Product of Progress for Canada's Growing Industries

POSITIVE GRIP

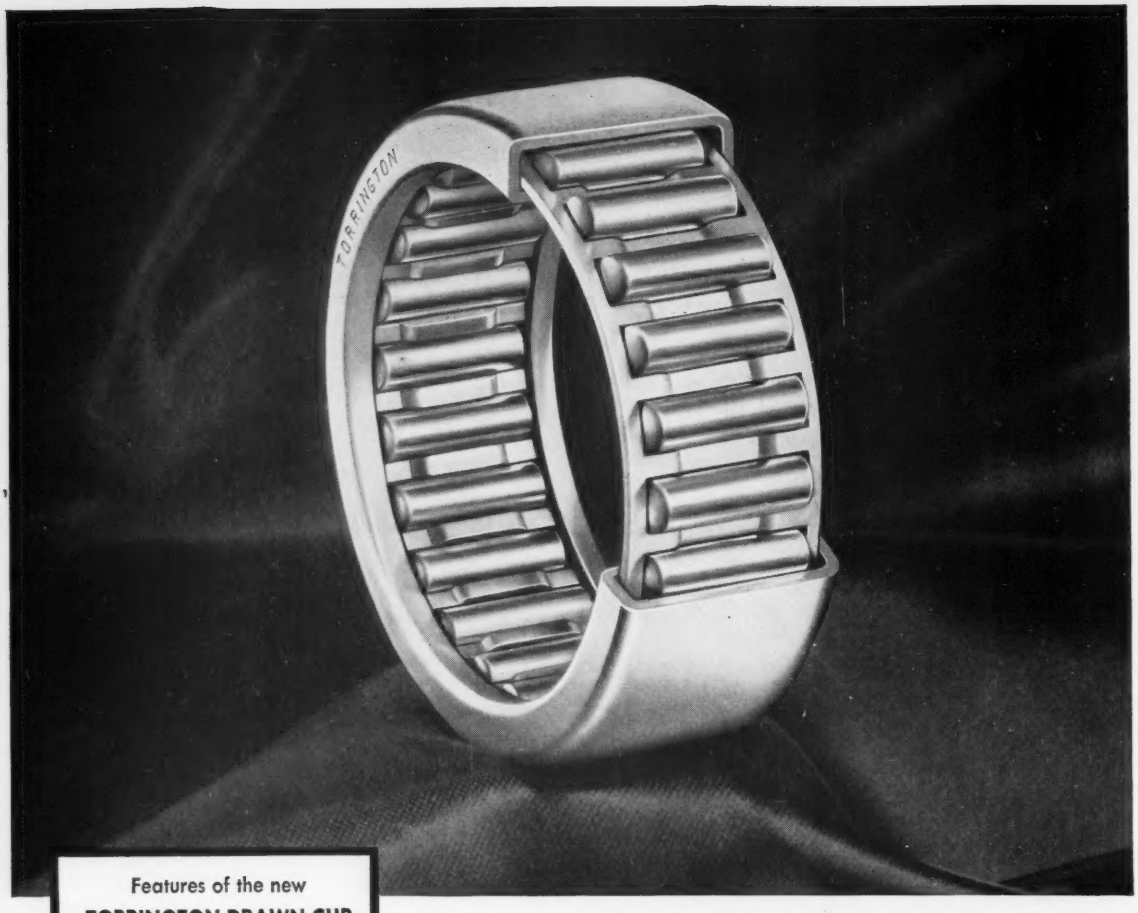


Positive engagement of the Timing Belt's teeth with pulley grooves assures no slippage, no creep, no power loss, precision control of speed ratio.

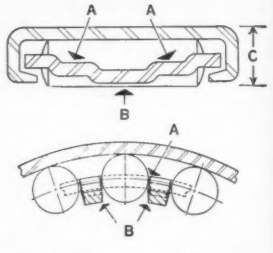
DOMINION RUBBER

Dominion Rubber

Mechanical Goods Division



Features of the new
TORRINGTON DRAWN CUP ROLLER BEARING



- rollers end-guided at pitch line (A)
- shaft-riding retainer (B) designed to permit lubricant circulation
- high capacity in small cross section (C)
- long pregreased life
- efficient at high speeds
- mounted by press fit
- simple housing design
- low unit cost

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a new low-cost precision roller bearing...

THE TORRINGTON DRAWN CUP ROLLER BEARING

For the first time, the advantages of drawn cup outer race construction are available in a precision roller bearing.

This compact, lightweight bearing consists of spherical end needle rollers, a one-piece hardened steel retainer and case-hardened thin-section outer race. Designed to run on a hardened shaft or with an inner race, this new series takes a press fit in a simple housing without snap-rings or shoulders.

Highly efficient roller guidance and lubrication are outstanding features. The shaft-riding retainer contacts the roller ends at the pitch line where guidance can be obtained with the least effort. The design provides ample storage for lubricant and promotes its circulation.

These features make the new bearing particularly suited to applications requiring compactness with precision, high-speed endurance or long pregreased life.

For information on sizes now available and for application assistance, call on our Engineering Department or write for the new bulletin, "Torrington Drawn Cup Roller Bearings." *The Torrington Company Limited,* 925 Millwood Road, Toronto 17, Ont., Canada.

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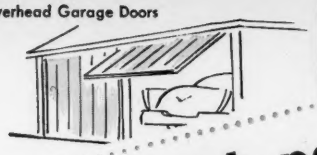
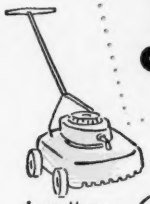
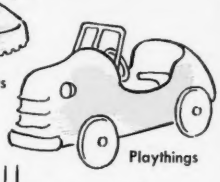
Overhead Garage Doors



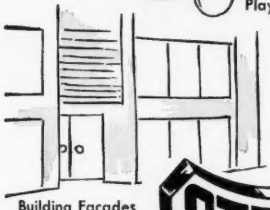
Holds paint like an artist's canvas!



Lawn Mowers



Playthings



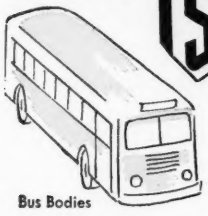
Building Facades

STELCO

"COLOURBOND"

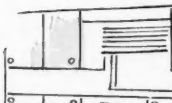
CONTINUOUS

GALVANIZED STEEL SHEETS



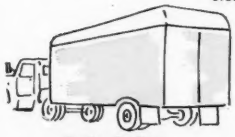
Bus Bodies

Utility Tables



Kitchen Equipment

Store Fronts

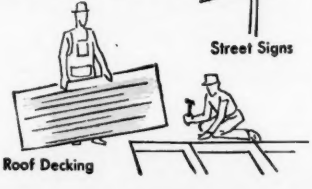


Trailer Bodies

Picnic Coolers

Fishing Tackle and Tool Boxes

Street Signs



Roof Decking

The coating of pure zinc on Stelco's new "Colourbond" Continuous Galvanized Steel Sheets is applied by an exclusive technique developed by Stelco . . . it produces a soft lustre finish, perfectly suited to the close adhesion of paint and particularly acceptable when a bright surface spangle is not desirable.

No surface preparation is necessary, and no primer coat needed.

As with all other galvanized sheets produced by Stelco's patented continuous galvanizing process, the bond between the zinc and the steel is so tight that the sheets can be worked or formed to the limits of the base steel itself, without any sign of cracking or peeling of the zinc coating.

For every product or building application where a painted surface is required to combine with an anti-rust, anti-corrosion surface use Stelco "Colourbond" Galvanized Steel Sheets — available now, in sheets or coils.

For full information and metallurgical service, contact any Stelco Sales Office.

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Executive Offices: Hamilton and Montreal

Sales Offices: Halifax, Saint John, Montreal, Ottawa, Toronto, Hamilton, London, Windsor, Winnipeg, Edmonton, Vancouver. J. C. Pratt & Co. Limited, St. John's, Newfoundland.

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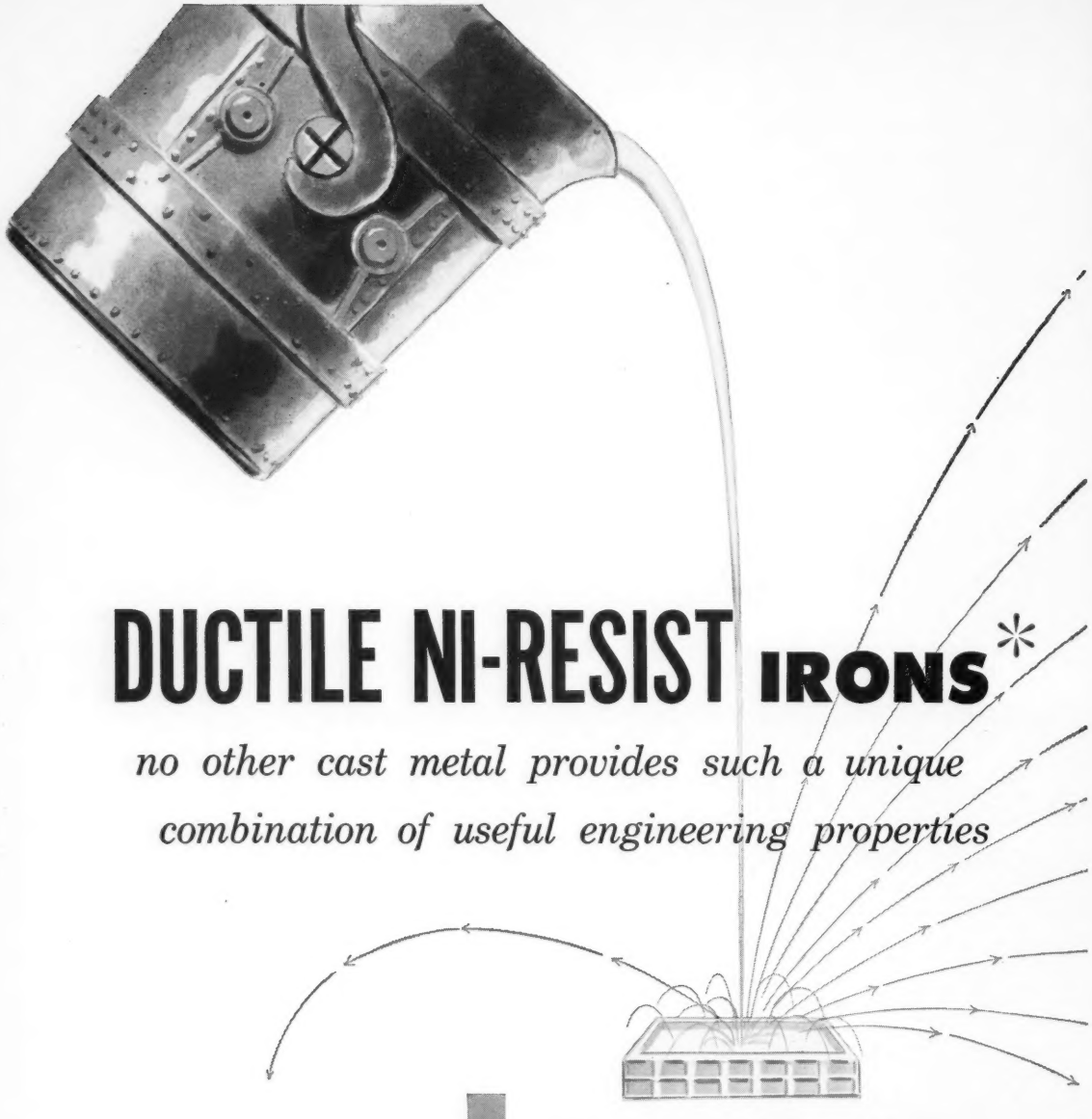

DUCTILE NI-RESIST IRONS*

no other cast metal provides such a unique combination of useful engineering properties

ENTIRELY CI CANADIAN

* For detailed information write for a copy of "Ductile Ni-Resist". You are not obligated in any way.

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FOUNDRY AND MACHINE DIVISION

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DN-1

Corrosion Resistance:

Acid, alkali, and salt handling problems have been solved by Ductile Ni-Resist.

Weldability:

No difficulty in welding in shop or field.

Toughness:

Impact resistance of Ductile Ni-Resist is comparable to that of steel at ordinary temperatures; an important plus is that it suffers no appreciable embrittlement at sub-zero temperatures.

Erosion Resistance:

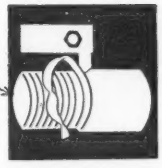
The Ductile Ni-Resist series of irons show economical service under many erosive conditions; and resistance to erosion as in a pump impeller is outstanding.

Ductility:

Ductile Ni-Resist irons possess 10 to 40% elongation in a tensile test, ample for all normal service applications.

Castability:

Good flowing quality of Ductile Ni-Resist permits the casting of intricate designs, which are difficult to produce in some other cast corrosion-resistant metals.



Machinability:

Machinability rates of Ductile Ni-Resist are of the same order as those of conventional pressure type gray iron.

Heat Resistance:

A high order of heat resistance is available with Ductile Ni-Resist up to 1300 deg. F. Certain types are recommended for service up to 1500 deg. F. Ductile Ni-Resist irons not only reduce the rate of oxidization, but also the oxidization products adhere tenaciously to the base metal.

Controlled Expansion:

Expansivities from 4.5 to 10.4 millionths per deg. F. are available with the different types of Ductile Ni-Resist.

Wear Resistance:

Metal to metal rubbing parts last much longer and perform better, especially under corrosive conditions, when made of Ductile Ni-Resist.

Non-Magnetic:

Some types of Ductile Ni-Resist irons are non-magnetic, and are therefore useful in many applications in the electric and allied fields where this quality, and the many others that this alloy has to offer, are required.

Here's where you'll find the RIGHT PLASTIC backed by the RIGHT SERVICE

FROM DOW—A family of plastics to meet specific needs.

***STYRON**

STYRON 666 — a widely used general purpose formulation of high purity with physical properties that include good aging characteristics, clarity and surface hardness.

STYRON 688 — features good moldability with controlled flow and pressure distribution in mold cavity. Exceptional balance of properties.

STYRON 689 — excellent moldability and brilliant sparkle make this formulation ideal for crystal parts. Designed especially for injection molding, having very high flow rate.

STYRON 475 — possesses exceptional uniformity, high impact strength and high elongation. It has 3 to 5 times greater impact strength, 10 times greater elongation than general-purpose polystyrene.

STYRON 440 — developed for applications such as radio cabinets where high impact and heat resistance are required.

STYRON 700 — very high heat resistance and notable gloss.

STYRON 480 — super high-impact formulation with excellent heat resistance. Ideal for uses such as lawn mower wheels, pump impellers and fittings for pipes.

***TYRIL**

A new name in plastics based on styrene and acrylonitrile. Tyril offers unequalled characteristics and balance of properties: high tensile strength, superior toughness, crystal clarity, good heat resistance, outstanding moldability, high chemical resistance and excellent aging characteristics. It's a natural for use in refrigerators, tumblers, houseware goods and numerous other products.

***ETHOCEL**

One of the first plastics, combining light weight and exceptional toughness. Resists many chemicals over a wide range of temperatures. One of its formulations is self lubricating for such applications as roller wheels and oil-less gears.

* Trade marks of Dow Chemical of Canada, Limited

Most often, getting the right plastic for a specific use depends on two things: (1) a broad range of plastics from which to select the exact properties needed and (2) adequate back-up service from the manufacturer. From Dow you get both!

A pioneer in thermoplastics development and production, Dow, today, is the leader in this field. And as such, Dow maintains extensive laboratories in Sarnia where the toughest problems meet research scientists, technicians and engineers. Many of these experts have grown with the industry from its beginning. Their experience — plus the talents of production, styling, colour and marketing service — combine to give you unequalled support in selecting, fabricating, forming and selling plastic products.

Papers, technical bulletins and brochures covering every detail of plastics applications, methods and equipment have been written and kept up to date. This literature as well as personal attention is yours for the asking. Contact our nearest sales office, or write direct to: DOW CHEMICAL OF CANADA, LIMITED, 600 University Avenue, Toronto 2, Ontario.

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INCO NICKEL ALLOYS

NICKEL

PROTECTS FOOD

Commercially pure malleable nickel gives good corrosion resistance to alkalies and organic compounds. Strong, hard and tough, nickel has good thermal and electrical characteristics. Widely used to protect the purity of foods and chemicals in processing.

LOW CARBON NICKEL

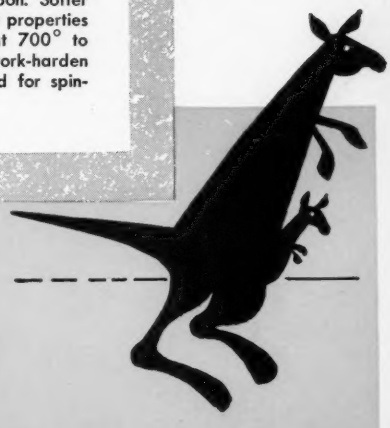
BEST FOR SPINNING

Essentially the same composition as nickel with the addition of a small amount of carbon. Softer with lower mechanical properties and better service at 700° to 1200°F. Does not work-harden as rapidly—preferred for spinning and coining.

"D" NICKEL*

MAKES BETTER SPARK PLUGS

A nickel-manganese alloy with greater resistance to oxidizing sulphurous conditions. High resistance to spark erosion; extremely suitable for spark plug electrodes and carbon electrode holders; glass machinery parts, high-temperature furnace parts and ignition tubes.



DURANICKEL*

IDEAL FOR SPRINGS

An age hardenable alloy which has extremely low relaxation making it ideal for springs subject to relatively high stress up to 600°F. Used for paper machine shaker springs, diaphragms, laundry clips, infra-red bulbs, spark plugs and electric toasters.

PERMANICKEL*

GOOD CONDUCTOR OF ELECTRICITY

Approximately the same mechanical properties as Duranickel with corrosion resistance equal to Nickel. Magnetic at room temperature and a good conductor of electricity and heat. Used for current carrying springs, clips, diaphragms, and other contact arms.

These INCO NICKEL Alloys provide a wide range of useful characteristics and mechanical properties which make them highly desirable for many difficult applications in industry. Most of the alloys in this group are available in standard forms . . . and Inco Customer Service goes with them . . . to help you solve metal problems. Write today for complete information.

**Trade Marks*

INCO THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED

another **JENKINS** installation!

The New Federal Building
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Consulting Engineers:
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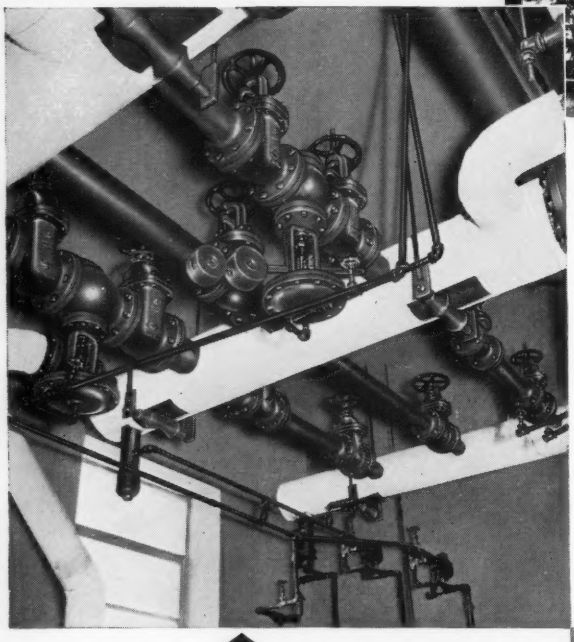
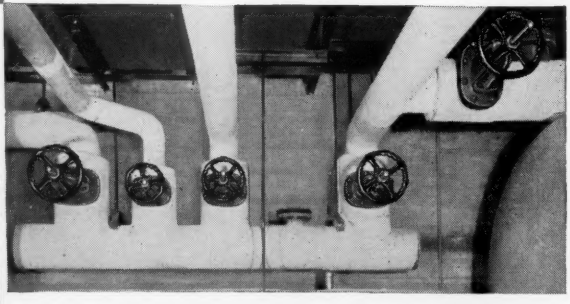
Plumbing & Heating:
CANADIAN COMSTOCK COMPANY LTD.



Bronze and Iron-Body Gate Valves on the main steam headers in the penthouse, supplying fan rooms and North and South zones.

Rising Spindle Iron-Body Gate Valves on the main water header.



Edmonton's new 10-story Federal Building typifies the city's growing stature as one of the world's leading oil capitals. Scheduled to open in January, 1958, the massive building will house every federal department except the Post Office and the Unemployment Insurance Commission. Reliable Jenkins valves have been installed by the contractors to direct and control the flow of heat for the $6,000,000 building. For unsurpassed efficiency, long life, and trouble-free maintenance, *it pays to deal with specialists.* When specifications call for valves, call Jenkins.

Making Quality Valves is Our Business — Our Only Business.

The Jenkins "Diamond" trade mark is your assurance of complete satisfaction.

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need a new twist?

Something new on the drawing board? Then *now* is the time to call in Wallace Barnes' *specialists* in spring design. They are ready to accept your precision mechanical spring problem and help design the exact type, size, tension and temper of spring to do your *specific* job best!

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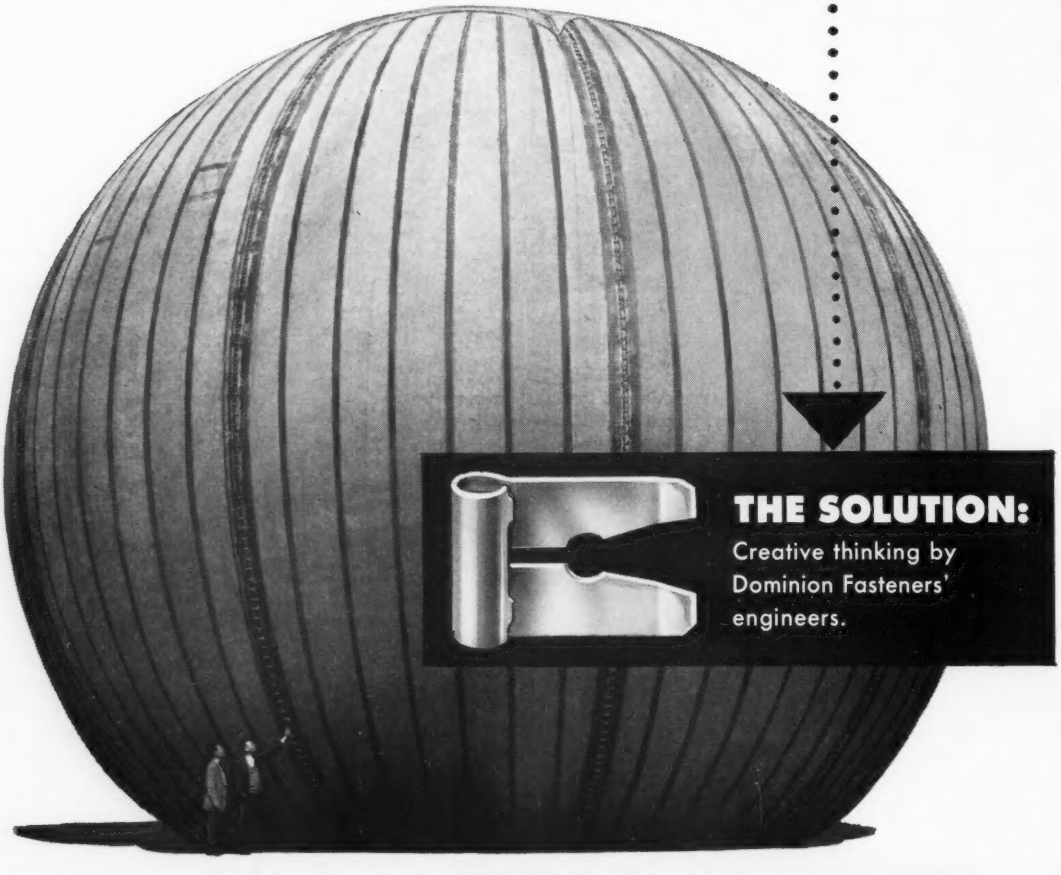
THE PROBLEM:

To create and manufacture a practical fastening device to close the seams of the world's largest* Radome . . . to make it simple enough to do the job quickly and easily in sub zero temperature while wearing heavy Arctic-type mitts.



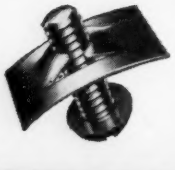
THE SOLUTION:

Creative thinking by Dominion Fasteners' engineers.

Solving tough problems is routine at the Hamilton plant of Dominion Fasteners Ltd. Through a combination of modern facilities and creative personnel, this Canadian company is continually inventing, developing and producing better fastening methods for a wide variety of industries.

Whether you make Radomes or radiators, Dominion Fasteners Ltd. are always ready and able with an efficient, economical solution to your fastening problems.

*The world's largest air-supported Radome was recently completed by Firestone Tire & Rubber Co. of Canada Ltd. Constructed for the USAF by the Electronics Division of Westinghouse under a contract from ARDC's Rome Air Development Center, the Radome measures 61 feet in diameter and is designed to protect radar antennae equipment from extreme weather conditions at remote defense installations.

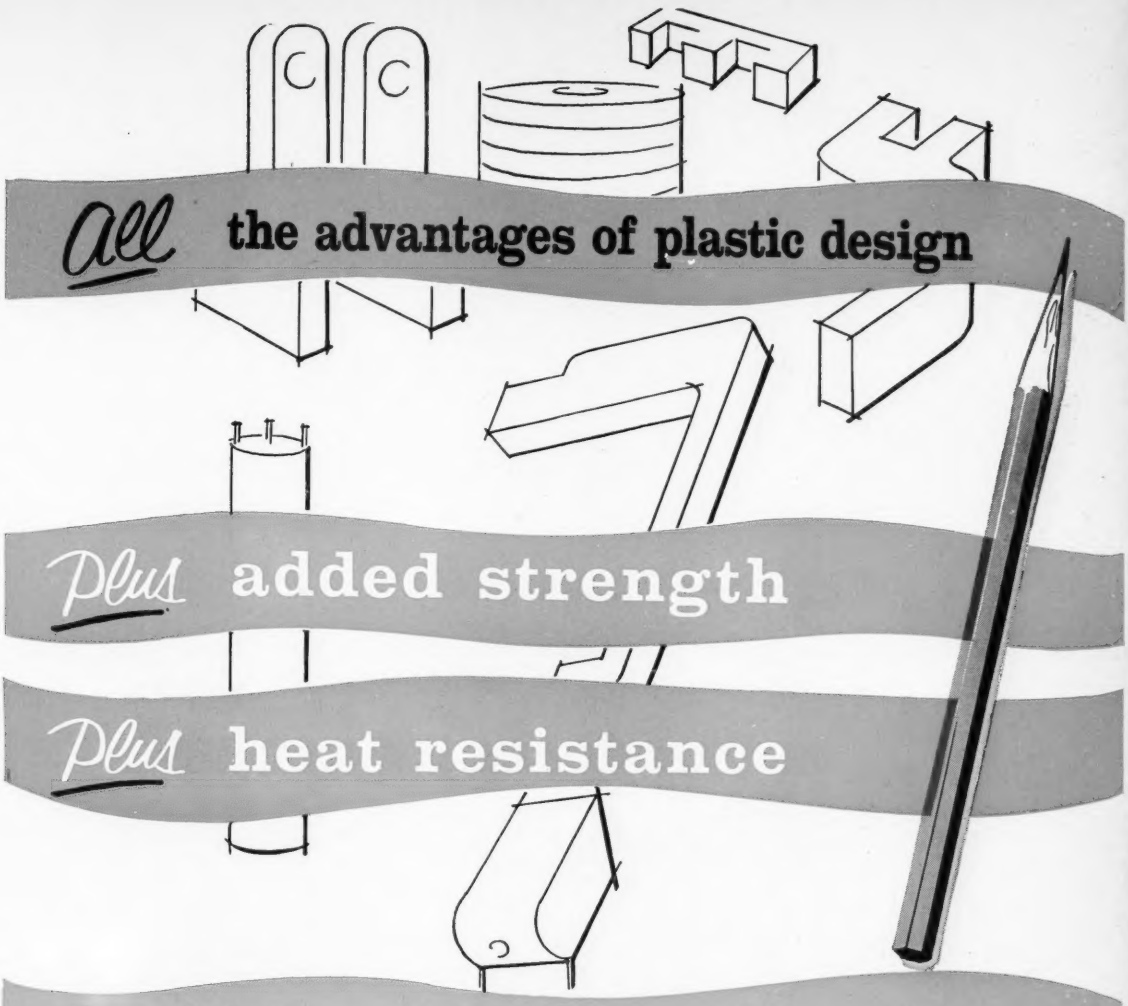


The flat-type Speed Nut from which has grown a family of over 6000 types and sizes of spring tension fasteners.

DOMINION FASTENERS LIMITED

Canadian Licensee and Manufacturer of HAMILTON, ONTARIO

TINNERMAN Speed Nuts TRADE MARK a Geo. A. Tinnerman corporation



All the advantages of plastic design

Plus added strength

Plus heat resistance

Equals FIBERGLAS* reinforced *plastics*

When plans are in the fluid stage . . . that's the time to consider what reinforced plastics can offer. Most plastics are out-classed when it comes to the questions of strength and heat resistance. But Fiberglas reinforced plastics are incredibly tough and show an excellent heat resistance. They have colour and lightness. You can mould them to suit the most intricate shape. They resist abrasion and withstand weathering.

*T.M. Reg'd.

IT'S AMAZING THE DIFFERENCE FIBERGLAS MAKES

FIBERGLAS*
FIBERGLAS CANADA LIMITED

FURTHERMORE
These familiar plastic items were made possible by *Fiberglas Reinforced Plastics*

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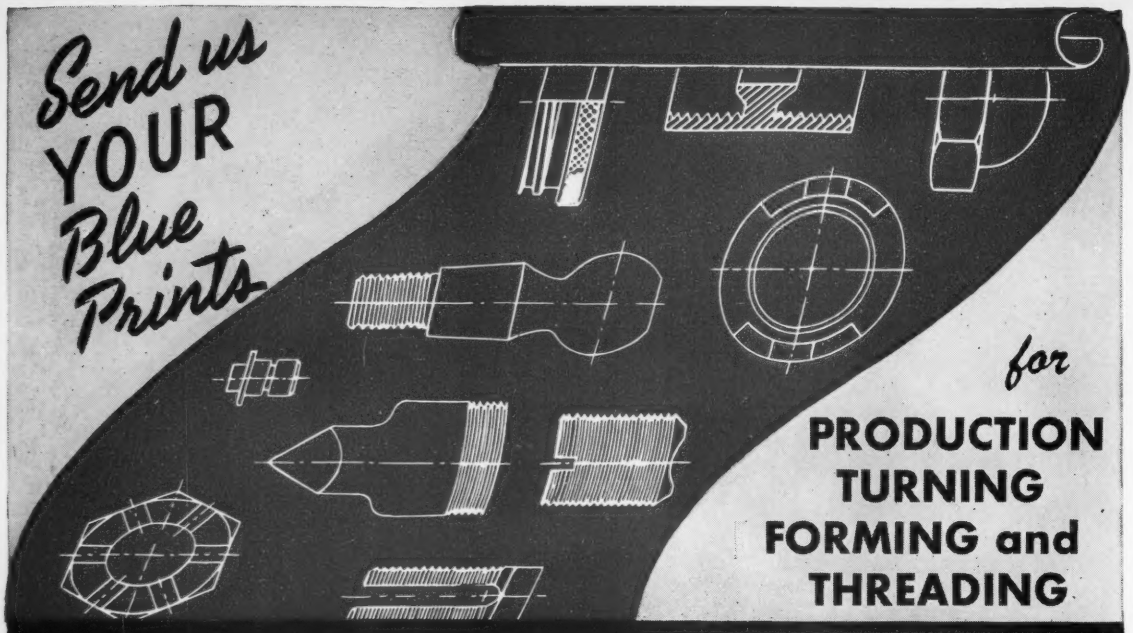
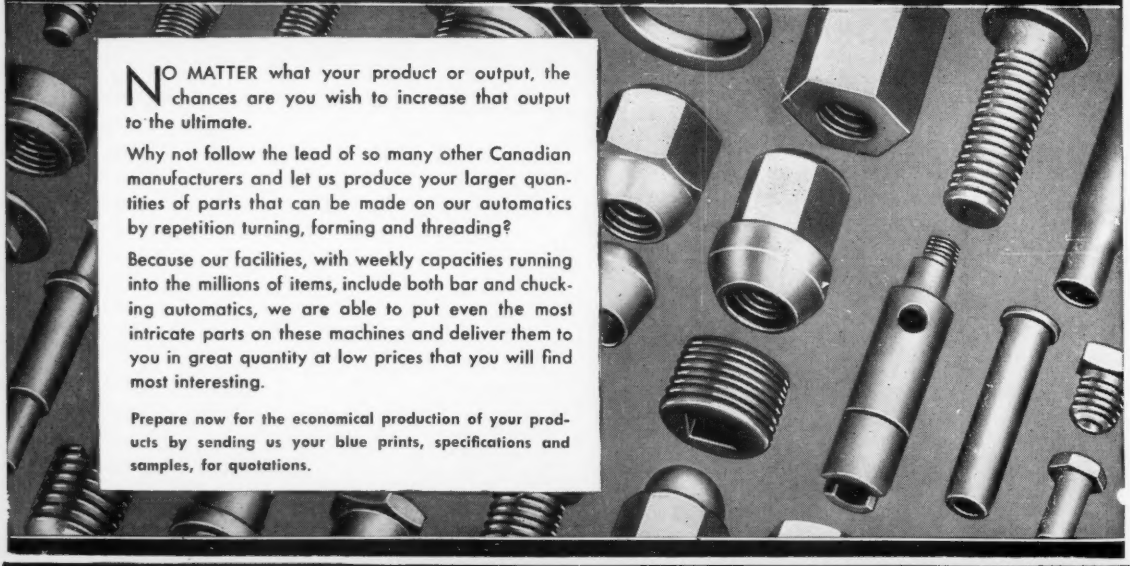


for

PRODUCTION TURNING FORMING and THREADING

ACME



NO MATTER what your product or output, the chances are you wish to increase that output to the ultimate.

Why not follow the lead of so many other Canadian manufacturers and let us produce your larger quantities of parts that can be made on our automatics by repetition turning, forming and threading?

Because our facilities, with weekly capacities running into the millions of items, include both bar and chucking automatics, we are able to put even the most intricate parts on these machines and deliver them to you in great quantity at low prices that you will find most interesting.

Prepare now for the economical production of your products by sending us your blue prints, specifications and samples, for quotations.

CANADIAN ACME SCREW & GEAR, LIMITED

SPECIAL SCREW PRODUCTS DIVISION — 207 WESTON ROAD, TORONTO

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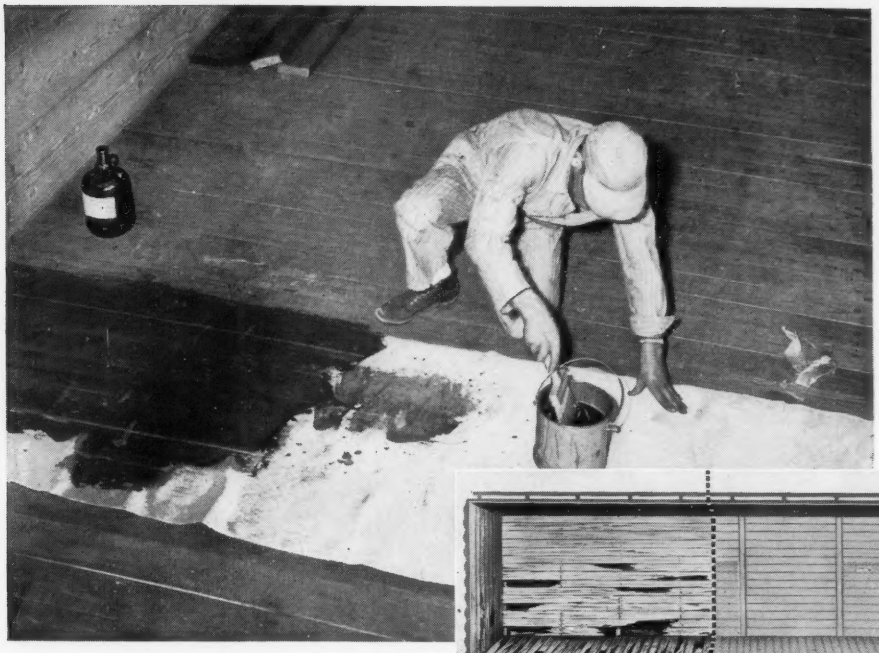
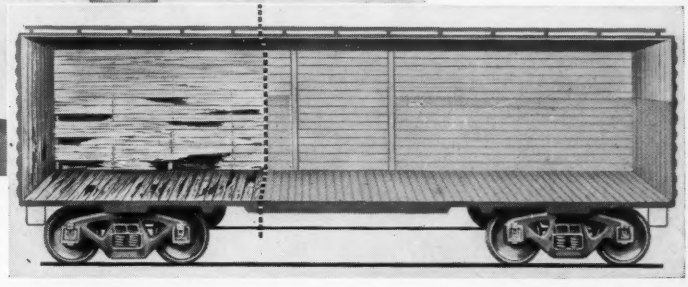
"Beat-up boxcars made like new with Espey Carliner!"



Reichhold polyester resin used in Espey Carliner is applied over glass cloth on floor of freight car. The resin coating goes on easily, dries fast to a hard, durable surface.

Low-cost lining provided by Espey Carliner covers cracks, gouges, oil spots. It seals seams, joints and corners against moisture and vermin. Old car is transformed into top-revenue carrier.



Tough RCI resin coating upgrades old cars in just a few hours!

● The heavy industrial equipment transported by railroads splinters and spoils wooden walls and floors of freight cars. This wear-and-tear progressively downgrades the cars to class C or D — cars unsuitable for commodities like edible grains.

Now, however, the Espey Carliner, developed by Spring Packing Corp. of Chicago with technical help on resin coatings from Reichhold, returns these cars to "class A" status. *In fact, Carliner treatment actually results in car walls and floors that are "better than new!"*

Two coats of special RCI polyester resin, brushed onto glass cloth, do the job quickly and economically. The resulting interior surfaces are *harder, more durable, more easily cleaned, provide better insulation, and are more resistant to moisture and chemicals than the original wooden walls and floors.* The lining is unaffected by freezing, heat, corrosion or shock.

"Reichhold was a great help to us with technical service" says John T. Landreth, president of Spring Packing. "They worked closely with our people, tailored just the right polyester resin formulation for our need. And they make fast deliveries, too!"

Whether *you're* interested in plastic coatings, molded or laminated plastics, RCI Technical Service can find a resin formulation that gives *you* important advantages, too! Write RCI about polyesters for your products. And ask for *booklet A.*

Creative Chemistry . . .
Your Partner in Progress

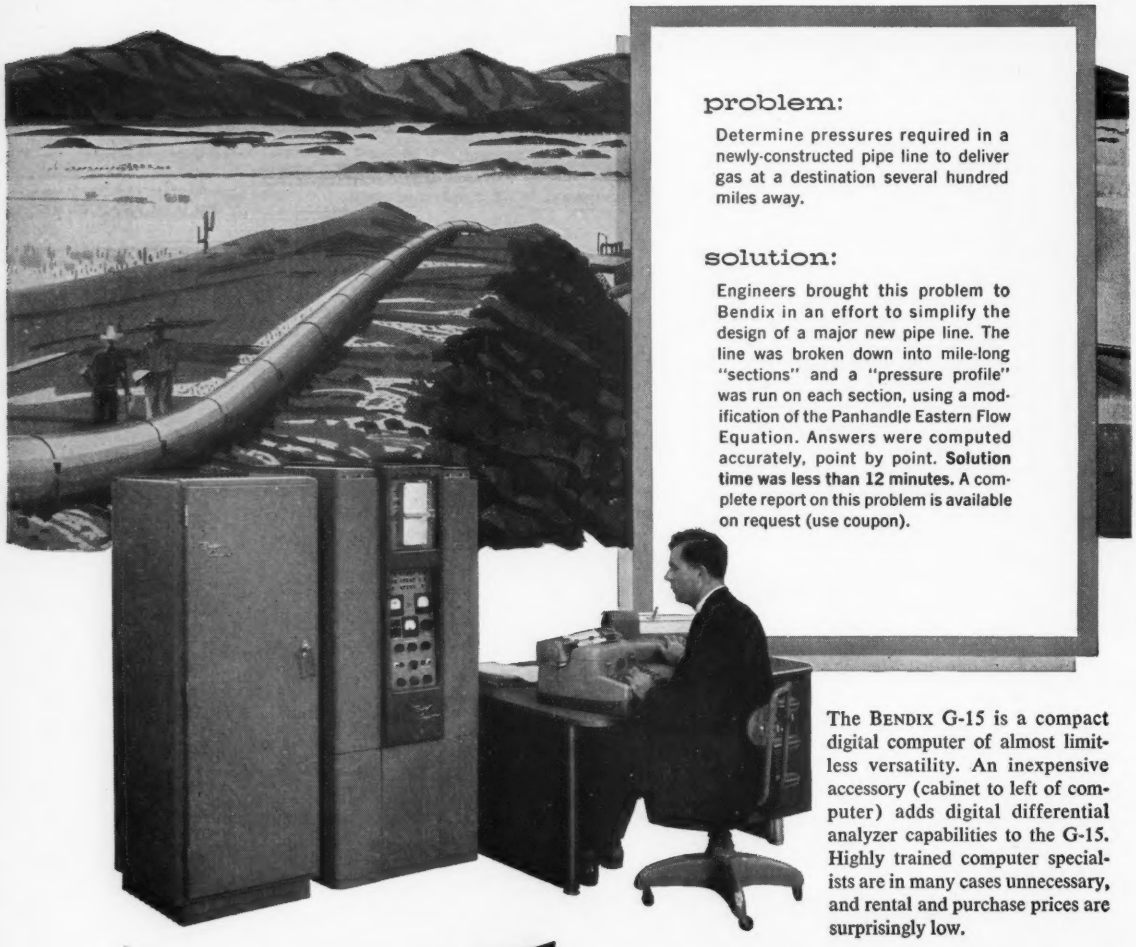
RCI

REICHHOLD

Synthetic Resins • Chemical Colors • Industrial Adhesives • Plasticizers
Phenol • Formaldehyde • Glycerine • Phthalic Anhydride
Maleic Anhydride • Sodium Sulfite • Pentaerythritol • Pentachlorophenol

REICHHOLD CHEMICALS (CANADA), LTD. • 1919 Wilson Ave., (Weston), Toronto 15, Ontario

a Bendix Computer simplifies cross-country pipe line construction



problem:

Determine pressures required in a newly-constructed pipe line to deliver gas at a destination several hundred miles away.

solution:

Engineers brought this problem to Bendix in an effort to simplify the design of a major new pipe line. The line was broken down into mile-long "sections" and a "pressure profile" was run on each section, using a modification of the Panhandle Eastern Flow Equation. Answers were computed accurately, point by point. **Solution time was less than 12 minutes.** A complete report on this problem is available on request (use coupon).

The BENDIX G-15 is a compact digital computer of almost limitless versatility. An inexpensive accessory (cabinet to left of computer) adds digital differential analyzer capabilities to the G-15. Highly trained computer specialists are in many cases unnecessary, and rental and purchase prices are surprisingly low.

Bendix Computer

COMPUTING DEVICES OF CANADA LIMITED
P.O. BOX 508, OTTAWA, CANADA.

5721

COMPUTING DEVICES OF CANADA LIMITED
P.O. BOX 508, OTTAWA, CANADA.

Please send me more details on Model G-15 General Purpose Digital Computers, and include a copy of the pipe line report.

NAME_____

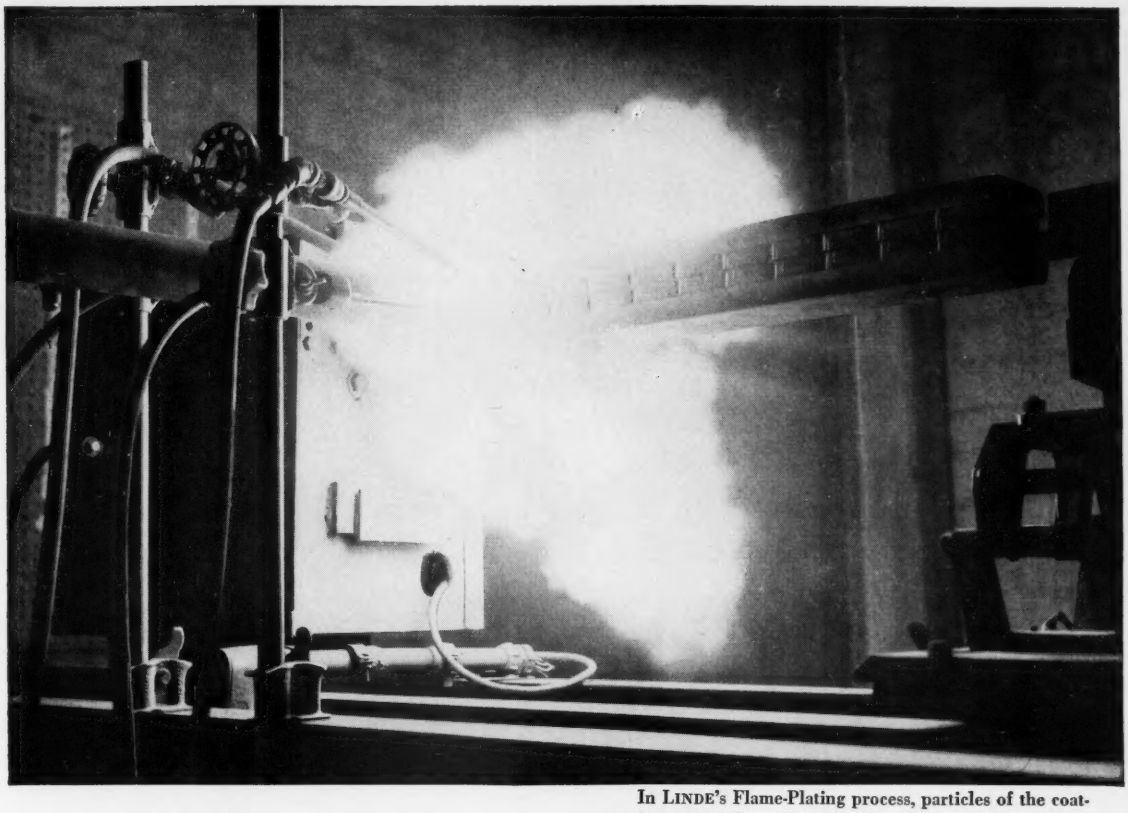
TITLE_____

COMPANY_____

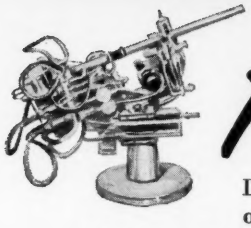
ADDRESS_____

WESTERN DIVISION — Commercial Building, Edmonton, Alberta.

A LOW-POROSITY, WEAR-RESISTANT ALUMINUM OXIDE COATING



In LINDE's Flame-Plating process, particles of the coating material are literally *blasted* onto the workpiece.



Flame-Plating by *Linde*
Trade Mark

LINDE's Flame-Plating method of coating metal surfaces now provides extra wear resistance for parts subject to extremely hard wear and high temperatures. This new high-purity aluminum oxide coating, blasted from the Flame-Plating gun, builds up on the workpiece in desired thicknesses from .002 to .040 inch. With a porosity of *less than 1 per cent*, the aluminum oxide coating can be used at temperatures up to 1750 degrees F.

The hardness of aluminum oxide coatings, Flame-Plated by LINDE, ranges from 1000 to 1200 VPN. Metallurgical properties of the base metal are not modified by the Flame-Plating process because the part being plated always remains at a temperature of 400° F. or below. The bond between coating and base metal is exceptionally strong with aluminum. Aluminum oxide coatings can be used in as-coated condition (approximately 120 microinches rms), or finished to better than 1 microinch rms.

Flame-Plated coatings of aluminum oxide provide resistance to wear, and to chemical action in high temperature applications. Applications are found in thrust bearings, pump plungers, thermocouple tubes, gas turbines, guided missiles, and other devices. Either aluminum oxide or tungsten carbide can be Flame-Plated on most metals. If you have a special wear problem, LINDE's Flame-Plating Department will gladly help you to reach a solution. Write to "Flame-Plating Department 307."

LINDE AIR PRODUCTS COMPANY

Division of Union Carbide Canada Limited

40 St. Clair Avenue East UCC Toronto 7, Ontario

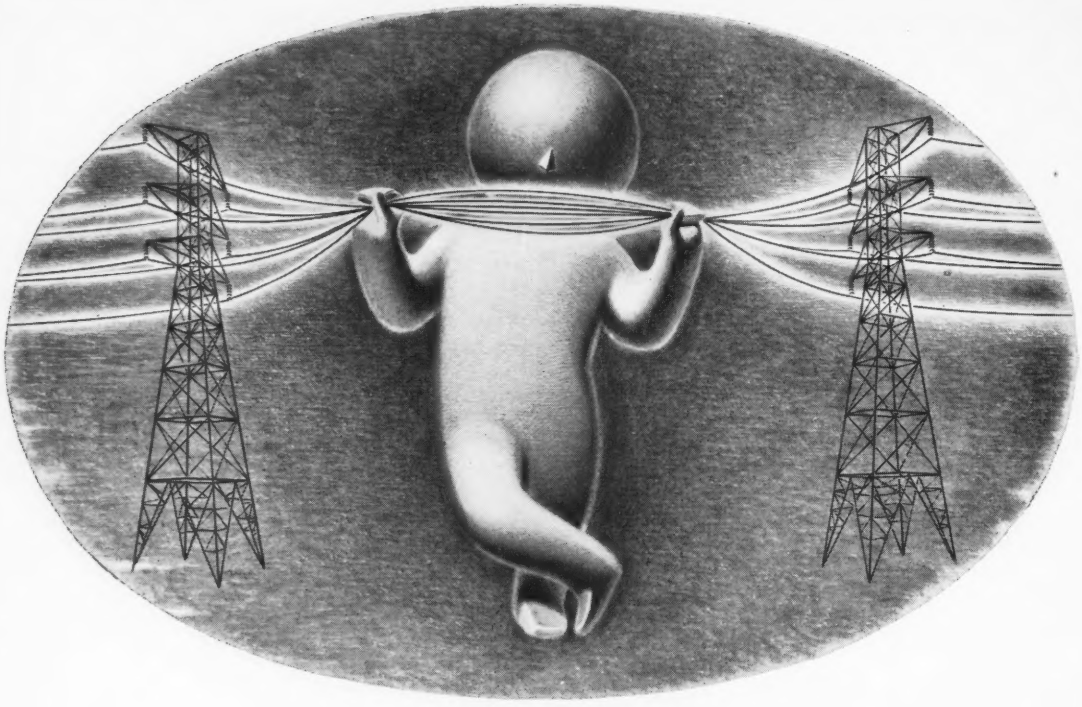
Montreal Winnipeg Edmonton Vancouver

"Linde" is a registered trade mark.

How can you benefit from the amazing

ELECTRICAL PROPERTIES

of G-E silicone rubber AT HIGH TEMPERATURES?

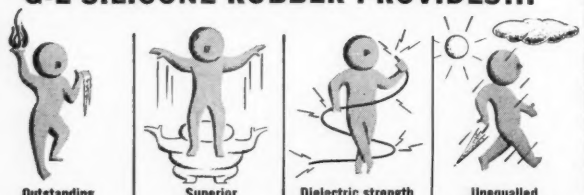


Amazing electrical properties at high temperatures are among the outstanding characteristics of General Electric silicone rubber. It is ideal for wire and cable insulation where overloads or space limitations dictate a heat-resistant dielectric. Cables have been redesigned with G-E silicone rubber to carry nearly *twice the current—with no increase in size!* G-E silicone rubber not only provides Class H insulation, but can be used to improve Class B insulation as well.

Where can YOU use G-E silicone rubber? There's a kind for almost every requirement, classified according to dominant property for easy selection and specification. For example: Class 300 offers the best recovery after compression *of any known rubber!* Class 500 provides flexibility *at 130°F below zero!* Which class is best for *you?*

SEND FOR A FREE
***"LIGHTNING SELECTOR"*—TODAY!**

G-E SILICONE RUBBER PROVIDES...



Outstanding resistance to extreme temperatures

Superior resistance to compression set

Dielectric strength stable at high temperatures

Unequalled resistance to aging, ozone, weathering

Chemical Materials Sales
INDUSTRIAL PRODUCTS DEPARTMENT
CANADIAN GENERAL ELECTRIC COMPANY
LIMITED

Chemical Materials Sales
Canadian General Electric Co. Ltd.
940 Lansdowne Ave.
Toronto, Ontario

Please send me technical data on G-E silicone rubber, including a free "Lightning Selector".

Name_____ Position_____

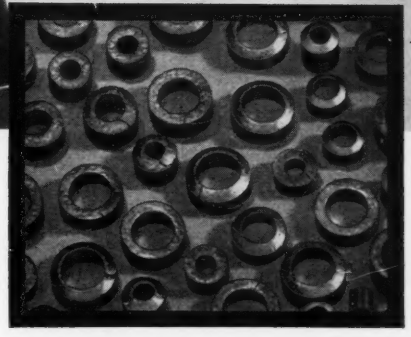
Firm_____

Street_____

City_____ Prov._____

457W-656

ONE OF THE GARLOCK 2,000



NEW–*The Most Universal Valve Packing Ever Developed!*

New Garlock 5022 is the nearest thing to a universal valve stem packing. Its many advantages far outweigh its slightly higher cost. Made of asbestos and TEFLON* pressed into a dense die formed ring, the new packing stands up against steam, water, mild acids, alkalies, and solvents. It is clean, cannot contaminate or discolor the product handled. It contains no graphite or lubricant; the TEFLON acts as an excellent lubricant yet does not exude, dry out, or burn out. Withstands temperatures to 500° F. Ideal for original equipment such as valves, faucets, appliances, etc.

Garlock 5022 and the other Garlock Molded Valve Rings listed at right are available specifically for production line use where accurately sized packings are required for high speed assembly. They are furnished in quantities of 500 and over, in many standard sizes or to your exact specifications.

Molded Valve Rings are another important part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The *only* complete line. That's why you get unbiased recommendations from your Garlock representative. Call him or write for Valve Ring Data.

OTHER GARLOCK VALVE RINGS

Garlock 160 Rings for use against steam at temperatures to 600° F.

Garlock 161 Rings for use against cold water and alcohol.

Garlock 162 Rings for use against cold oil, gasoline, benzol, chlorinated solvents, etc.

Garlock 163 Rings for use against high and low pressure steam, water, alcohol and some aqueous solutions.

Garlock 166 Rings for use against steam or gases to 600° F. hot or cold water, oils and solvents.

*DuPont Company Trade Mark

THE GARLOCK PACKING COMPANY OF CANADA LTD.

● General Offices: Toronto, Ont.
Branch Offices: Hamilton, Montreal, Winnipeg, Edmonton, Vancouver

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products

WHERE SPACE IS A BIG FACTOR...

choose the New Simpson SHALLOW CASE PANEL METERS

ONLY 1" IN DEPTH

1"

With the trend towards miniaturization in electronic apparatus requiring instruments, and to much more compact design in general, the need for panel meters with conventional readable faces — yet using a minimum of space behind the panel — is growing greater.

Bach-Simpson have met this need with the new Simpson Shallow Case line of instruments, requiring only standard 2½" or 3½" panel mounting holes, yet using only 1" of depth behind the panel.

Such a space saving instrument is only made possible by the famous Simpson Core Magnet Movement, which, *in addition* reduces the weight *by better than one-half* and provides a fully shielded movement.

The Simpson Shallow Case instrument can be mounted on magnetic or non-magnetic panels without a change in calibration, and has no external field to affect C.R. tubes, navigation compasses or any other device sensitive to magnetic fields.

SHALLOW CASE PANEL METERS are available —

in 2½" or 3½" round or square designs, in all D.C. ranges; as Voltmeters, Ammeters, Milliammeters, and Microammeters down to 100 microamperes. A.C. Rectifier ranges are also included.

Although available only to special order, there is no increase in price over the conventional Simpson instrument of similar style and range.

Write for complete dimensional details.

Bach-Simpson LIMITED

1255 Brydges St.
London, Ontario

SIMPSON ELECTRIC COMPANY, 5200 W. KINZIE ST., CHICAGO 44, ILLINOIS

▶▶▶ USING

DU PONT ELASTOMERS

neoprene · Hypalon®

in industry

HYPALON hose handles 60,000 lbs. of concentrated acid daily—in use 21 months without a failure

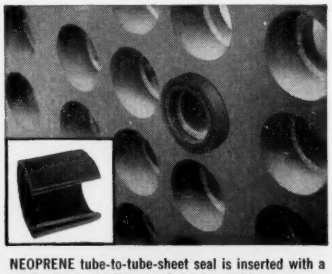
New neoprene grommet design saves $1500/yr. in material and labor costs on HCL heat exchangers

Normally, brass ferrules are used in sealing Karbate heat exchanger tubes at the tube sheet – but overtightening of the ferrules often occurs with resultant cracking of the expensive Karbate sheet. A patch is then necessary, and eventually the entire sheet must be replaced.

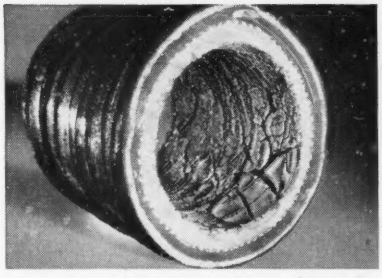
A molded neoprene seal, developed by a midwest firm, solved the problem. The seal encloses the end of the Karbate tubing and gaskets it firmly to the tube sheet. Success of the seal depends on the lasting resilience of neoprene for a cushioned, tight fit.

The firm reports 8 years of trouble-free operation with the neoprene seals – an approximate saving of $1500 a year in material and labor. An unusual story? No. Designers everywhere are taking advantage of neoprene's resistance to acids, heat, abrasion, flex cracking, oil and grease to make better-performing products for industry.

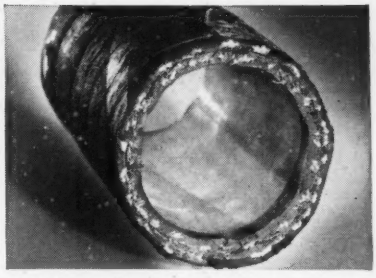
It will pay you to get all the facts about neoprene, Du Pont's all-purpose synthetic rubber. Just mail coupon at right for full information.



NEOPRENE tube-to-tube-sheet seal is inserted with a special hand tool. Neoprene's lasting resilience assures a tight fit without damaging the Karbate, while its acid resistance gives long service.



RUBBER hose previously used for acid discharge lines charred and cracked after only 8 weeks' use.



HYPALON hose in same service shows no internal acid damage, exterior aging or weather cracking in nearly 2 years.

Hose still safe and serviceable despite punishment of 60°-66° Be. sulfuric acid pumped under 30 psi

Two costly accidents in handling concentrated sulfuric acid brought the problem to a head for Rogers Cartage of Chicago – a tank truck hauler of acids and other chemicals. In one case, a conventional rubber discharge hose burst and sprayed several men with acid. In another instance, a rubber hose burst and an entire 30,000-lb. truckload of acid was lost.

HYPALON supplied the answer and ended the accidents. Experimental use on their company trucks worked so well that Rogers equipped their entire fleet with 3" HYPALON discharge hose. It provides the safety of exceptional acid resistance and is far easier for the drivers to handle than swing-joint steel pipe.

Jack Kidder, Safety Director at Rogers Cartage, has this to say about HYPALON: "That hose was a real life saver. We started using it in August, 1955, and we have never had a HYPALON hose failure." He also adds . . . "inspection of the hoses indicated no burning or breaks, and they appear as new as the day they were placed in service."

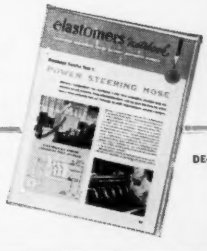
HYPALON has qualities you will find useful in hoses, tank linings, and other applications. Resistance to strong oxidizing acids is just one. We would like to tell you about many others. The coupon will bring you the information.

One driver easily handles an 8' length of 3" HYPALON hose with safety.

DU PONT CANADA

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

MAIL THIS COUPON TODAY!



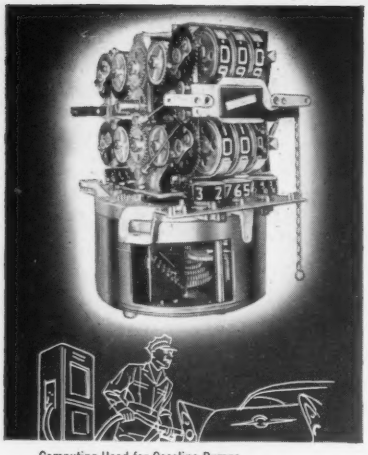
☐ I am particularly interested in _____

☐ Please add my name to the mailing list for your free publication, the ELASTOMERS NOTEBOOK.

DE-10

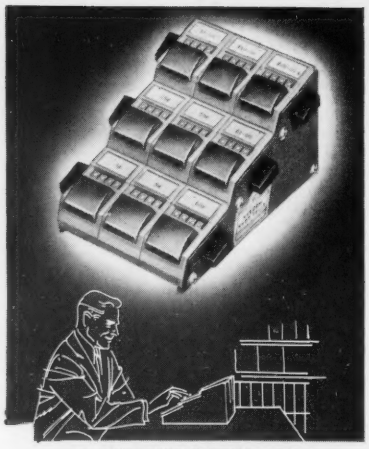
Du Pont Company of Canada (1956) Limited,
Chemicals Department, Room A-4,
P.O. Box 660 Montreal, Que.

Name _____
Firm _____
Address _____
City _____ Prov. _____

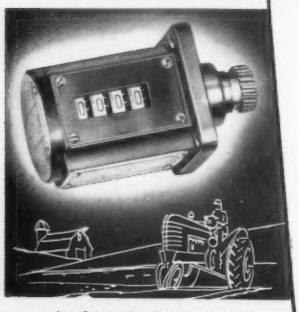


Computing Head for Gasoline Pumps

"Master Meter Duplicator" prints receipts for fuel oil delivered from trucks



"Vary-Tally" Multi-Unit Reset Manual Counter

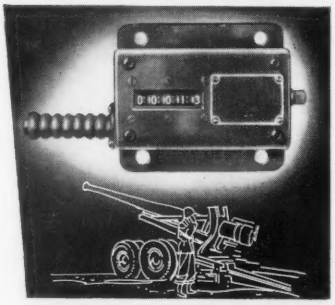


Rev-Counter for all types of engines

Everyone Can Count on VEEDER-ROOT

Everywhere you look in everyday life, you see a familiar face . . . the face of a Veeder-Root Counter or Computer. From gasoline pumps to fuel oil trucks to textile mills . . . in the home, on the farm, in business and commerce, in modern automated industry . . . Veeder-Root standard and special devices are keeping everything under *Count*rol . . . manually, mechanically, electrically. And the mathematical probabilities are mighty high that *you* can count on Veeder-Root, too . . . to your advantage and profit. Why not let us figure out how, *right now!*

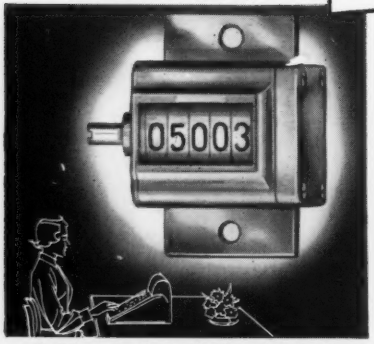
VEEDER-ROOT OF CANADA LIMITED
955 St. James St., Montreal



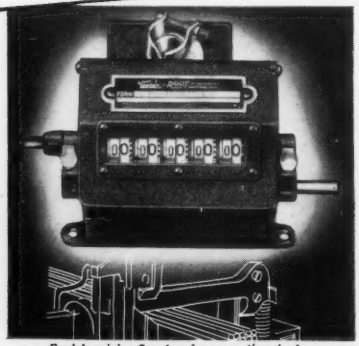
Recoil Counter for new 280 mm atomic cannon

2-3-4 Convertible Counters (and others) for textile machinery

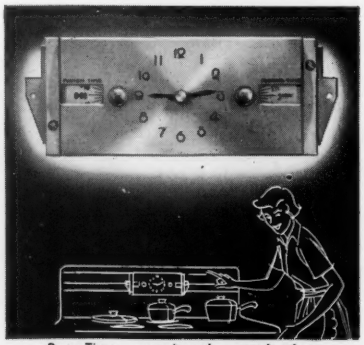
Fuel-Remaining Counter for aircraft . . . subtracts as fuel is used



Small Square-Case Counters for office and other machines



Predetermining Counters for preventing short and over-runs on production machines



Range Timer . . . easy to read . . . easy to set

Main Office and Factory: Veeder-Root Inc., Hartford 2, Conn., U.S.A. • Offices and Agents in Principal Cities

"The Name That Counts"

VIBRIN*

Reinforced Vibrin Therapy Tank now in use at Nora-Frances Henderson Hospital, Hamilton, Ont.; manufactured by Fiberplast Products Ltd.

aids the art of healing

Nothing but water and nature are at work here. Yet limbs crippled by polio or cerebral palsy may grow strong enough to walk again, or even to run. This is the magic of hydrotherapy.

There was a time when hydrotherapy tanks were made only of stainless steel, and many hospitals could not afford them. Today, a more versatile material does the job better and cheaper than steel. Its name is VIBRIN.

VIBRIN is much lighter than steel, yet stronger, pound for pound. It is less expensive to transport, easier to install, maintains warm water temperatures better. It is easy to keep clean and sanitary. VIBRIN won't rust, rot or chip — and its cost is a fraction of that of stainless steel.

Versatile VIBRIN is replacing metal and wood in one product after another — boats, furniture, automobile bodies, machine housings. Hand-layup over inexpensive, quickly made molds permits a manufacturer to get into production *within weeks*. VIBRIN may be what you need, to improve present products or create new ones.

For more information on VIBRIN, or expert technical assistance, contact Naugatuck Chemicals, Elmira, Ont. — or Naugatuck branches in Montreal, Toronto Winnipeg and Vancouver.

*VIBRIN: a polyester resin, reinforced with fibrous glass.

OTHER NAUGATUCK PLASTICS:

MARVINOL

Vinyl resin offering good physicals, easy processing, low temperature, flexibility, and resistance to oils, acids and wear.

KRALASTICS

Molding and extrusion compounds combining rigidity with exceptional toughness.

Naugatuck Chemicals

DIVISION OF DOMINION RUBBER COMPANY LIMITED

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ATLAS STEELS

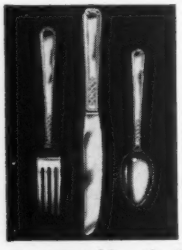
ATLAS STEEL NEWS

TOOL STEELS • HIGH SPEED STEELS • MINING DRILL STEELS • SPECIAL PURPOSE STEELS • STAINLESS STEELS

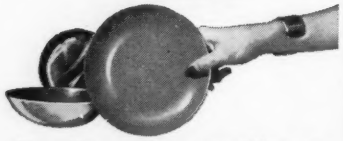
WHAT'S NEW IN STAINLESS products for the home

Stainless steel cookware with exclusive aluminum clad bottom (patented)—latest product from Sunshine Waterloo Co. Ltd.—features a design-award-winning nine-piece set including covered saucepans, skillets and boilers which are available in three sizes. For lifetime beauty and service these utensils are made of type 302 Atlas Stainless Steel.

True beauty with utility is evident in cutlery made of Stainless Steel. Illustrated, a knife, fork and spoon in Oneidacraft "FLIGHT" pattern which features elegant design with lifelong wear. Easy-to-clean, always sparkling, a pleasure and pride to have on your table—that's cutlery made from Stainless Steel.



CHALLENGE!



From Norway comes something new and exciting—stainless steel decorator bowls and plates in many beautiful "baked-on" enamel colours. Here is a challenge to the Canadian designer—a challenge that he can easily meet with Atlas stainless steel.

ATLAS STEELS LIMITED

WELLAND, ONTARIO

BRANCHES: TORONTO, MONTREAL, HAMILTON, WINDSOR, WINNIPEG, VANCOUVER

REPRESENTATIVES: LONDON, ST. CATHARINES AND SUDBURY. AGENTS THROUGHOUT THE WORLD.

Designers And Consumers Join the Swing to Stainless

Right across Canada—indeed, right across the world—more and more designers and consumers are turning to stainless steels for beauty and durability that defies time. In the kitchen . . . on the dining table . . . for the family car . . . for any place where lasting quality must stand the test—Atlas Stainless Steels are proving the wisest, most practical choice for better modern living. As Canada's *only* basic producer of stainless steel to any specification, Atlas Steels Limited is proud to be the leader in Canada's newest trend.

UPTREND IN USE OF STAINLESS FOR AUTOMOBILES

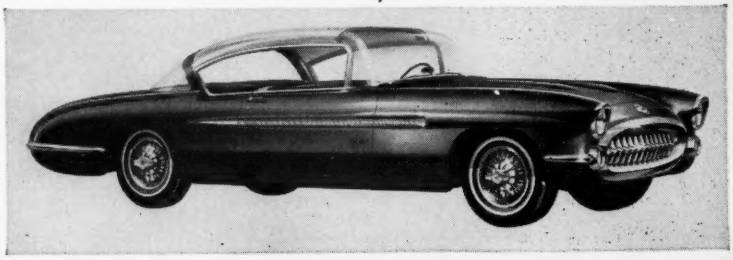
Stainless steel is making itself felt more and more in the automobile industry. For example, wheel covers for all the "big three" cars—Chevrolet, Plymouth and Ford—are now made for a lifetime of beauty with gleaming, rust-proof stainless steel. Plans for the future include many additions to the long list of parts and accessories now made from stainless.

Shown below is one of General Motors' cars of the future the "Impala" . . . which features shaded pale blue stainless steel roof, and a long blue fibreglass body embellished with tasteful silver blue stainless steel. As illustrated by this application, the natural beauty of stainless can be enhanced by a coat of transparent color glaze.

The "Impala" contains many spectacular new features which may be incorporated in future stock model G.M. cars.

Why G.E. Chose Atlas Stainless Steel Tubing For This Refrigerator De-Frost Valve

General Electric chose Atlas Stainless welded tubing, type 304, for this most intricate valve body because it provided a closer diameter tolerance than could be obtained with seamless tube. This is only ONE instance where Atlas Stainless Steel Pipe and Tubing has filled a vital need. For the whole story on these precision made Atlas products write us for this illustrated brochure.

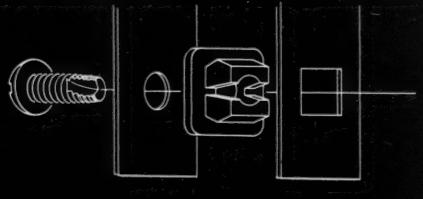


Plasti-Grommets®. . .An Easier Way to Speed Production

Self-Retaining Blind Screw Receptacles

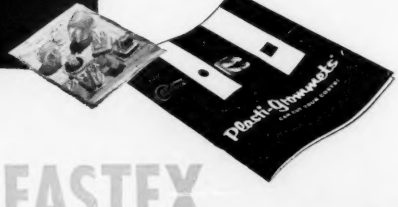
- non-corrosive
- non-conductive
- vibration-resistant
- does not chip or craze porcelain
- available in any color

35 sizes stocked



. . . and cut assembly costs, too! Plasti-Grommets snap into a prepared hole at the touch of a finger . . . replace other costly retained threaded receptacles, tapped holes or retained nuts. Locked in place by a thread-cutting screw, Plasti-Grommets provide a firm, durable, vibration-resistant fastener.

Developed at the Fastex creative engineering labs, Plasti-Grommets are a typical example of the simplification possible in multi-part assembly operations. Fastex volume production of metal and plastic components—on specialized manufacturing equipment—increases the economies gained through Fastex engineering ingenuity. These savings are being realized today in nearly every mass-production industry.



Test Plasti-Grommets®... send for informative brochure and free packet of these remarkable nylon blind screw receptacles... actually test them... see how they can reduce your costs!

-SL

SHAKEPROOF FASTEX

"FASTENING HEADQUARTERS"®

DIVISION OF CANADA ILLINOIS TOOLS LTD.
67 SCARSDALE ROAD • DON MILLS, ONTARIO

TORRINGTON PRESENTS:

An important new line of complete blower units for central air conditioning, heating and ventilating, in a wide range of sizes, full and three-quarter widths, and incorporating the following exclusive Torrington features:

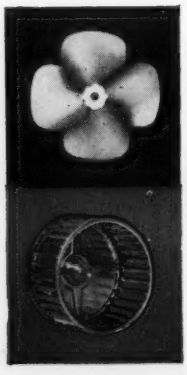
1. An exceptional new Center-Lock airotor introducing an entirely new principle of blower wheel construction in which (see insert) the center disc is dovetailed under pressure into the encircling blades. As a result of this design feature, the interlocking joint *tightens* under centrifugal force, eliminating blade rattle and angle warp at high speeds.

2. A Multi-Position blower housing, easily adaptable to left or right, up or down flow requirements, of the finest welded steel construction and special finish.

3. Availability in either belt-driven or direct drive assemblies.

4. Unit flexibility, providing feet, motor mounting assembly to meet your individual mounting requirements.

This new product line is a major development backed by all the standards of engineering quality consistent with Torrington leadership in the air impeller industry. Your inquiries are invited.



THE
TORRINGTON
MANUFACTURING COMPANY OF CANADA LIMITED
OAKVILLE. ONTARIO
TORRINGTON. CONNECTICUT · VAN NUYS CALIFORNIA

Letters from readers

Readers' viewpoints . . . queries

The heat pump

We in the air conditioning field realize that the heat pump for year round air conditioning is becoming important and sales of the product particularly in the United States are growing daily.

I think it timely and personally I would appreciate an article in your publication on heat pumps generally.

from V. M. Trojek, Supervisor—Product Design Department, Chatco Steel Products Limited, Tilbury, Ont.

(It so happens, as we informed Mr. Trojek, that an article on the heat pump is in source of preparation for Design Engineering—Ed.)

Brainstorming

We were interested to read your comments on Brainstorming.

Orr Associates have used these techniques for the last three years or more with startling results. Brainstorming can really work. Properly done, it can produce more ideas (and better ideas) than any other process we know of.

There are two interesting sidelights to this, though. Senior executives, particularly in engineering, often find it hard to think up new ideas. They are trained to think judicially rather than creatively. Younger men dream up ideas, older men criticize them. Through experience, we have found that senior executives can, in fact, contribute a great deal to brainstorming sessions. But they often need "loosening up" before they start. We have had to develop a "loosening up" technique for senior executives, but now find it works well.

The other point about brainstorming is strange. Exponents have found that women are either very good at brainstorming, or very bad. No one can agree which it is.

from Ernest Orr, Orr Associates Ltd., Product Planning, Toronto.

Fused-film wire

We are interested in contacting Adam Consolidated Industries, Inc., regarding their fused-film wire process which you briefly described under Reports in your August, 1957, issue.

Will you please let us know this firm's address so that we can get in touch with them soon?

from E. E. King, Chesley-Sarnes of Canada Limited, Essex, Ont.

(This information was supplied—Ed.)

Certified technicians

I read your editorial of May 57 with interest. Having been a research technician for a number of years, I would like to be certified and go on from there.

Would you be so kind as to forward the address of person concerned so that I may ask for details.

from Frank S. Cooke, 97 Stead Rd., Cardinal Heights., Ottawa.

(We did that—Ed.)

Plastic tooling

We have read in the June issue of Design Engineering that the American Society of Tool Engineers has compiled an extensive and complete bibliography on the subject of plastic tooling.

We would be indebted if you would please pass our name along to the Society, with the request for a copy of this most timely bibliography.

We thank you in advance for your co-operation.

from W. A. Campbell, manager, Western Branch—Chemical Division, P.O. Box 158, Vancouver 1, B.C.

(This we did—Ed.)

Ultrasonic tooling

In your August publication (under the article entitled Quotes) you make mention of an article in Philips Technical Review, Vol. 18, p.325, which deals with ultrasonic machining techniques.

It would be appreciated if you could obtain a tear sheet of this article for us. If this is not possible we would appreciate your advising us where we could obtain this volume.

from J. H. Ross, plant engineer, Noranda Copper and Brass Limited, Montreal East.

(The Philips people are getting a copy for Mr. Ross—Ed.)

Electrospark machine

Would you please send me more information on the machine that will drill any electro-conductive material, as stated in the June, Design Engineering magazine. I send you the article from the magazine. I just work in a small shop and I would like to know more about the machine.

from Bill Seminoff, 2336 St. Catherines St., Vancouver, B.C.

(We supplied the address of the E-Cell-O company—Ed.)

"Dear Editor . . ."

Readers are invited to participate in this column by sending criticisms, suggestions, queries and theories to: The Editor, Design Engineering, P.O. Box 100, Toronto, Ontario.

Next month in Design Engineering

NOVEMBER

Glassed pumps—How two manufacturers combined their skills to develop a pump with special pumping and corrosion resistance requirements.

Drafting efficiency—A study of the typical factors that play a part in the performance of the man at the drafting desk.

Stud welding—A process which permits the basic redesign of much equipment and gives simplicity and a saving in weight.

Dry compressed air—Wet compressed air can be an expensive nuisance. How can water be kept out of compressed air lines?

Rubber extrusions—The extrusion process is one of the oldest in the rubber industry and can be used with equal success for producing items from natural, synthetic and reclaimed rubber.

Hermetic sealing—What factors permit a true hermetic seal?

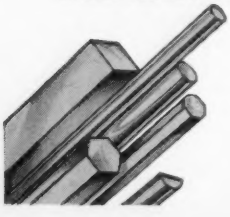
ANACONDA RODS...

for Screw Machine Products

The tremendous versatility of automation in modern manufacturing places a bigger burden on the designer and buyer of screw machine parts. And, the screw machine's ability to provide tolerances as close as .0005", and finishes heretofore obtainable only by centreless grinding, has left a tremendously wide choice in specifications.

The use of Anaconda Free Cutting Brass Rods frequently affords an excellent opportunity to cut costs by increasing the rate of production; and to obtain a higher-quality, better-looking, and more durable plated article. For more detailed information write for publication B-14, "Anaconda Rods—for Screw Machine Products" and Publication B-3, "Machining Copper and Copper Alloys". Anaconda American Brass Limited, New Toronto, Ontario. Sales Offices: Montreal and Vancouver.

Photographs courtesy Canadian Acme Screw and Gear Limited.



ANACONDA RODS

FOR SCREW MACHINE PRODUCTS

Aircomatic units in use here for mild steel building-up operations. This is a dredge discharge line elbow.

Process that speeds a quality weld

Production welding makes full use of its automatic features

About the Aircomatic process

The main advantages of the process for welding mild steel are: high speed welding; high quality welds which require minimum edge preparation and leave no slag to remove and which are deposited manually by flexible, manoeuvrable equipment that incorporates essentially automatic features.

Arrayed against the advantages are these major limitations, which at first glance appear rather formidable. The material cost of a given weld is two or three times greater than one deposited by the metallic arc process; the capital expenditure for a unit exceeds $1,500; and there is the problem of changing established welding procedures and training personnel. The process is not recommended for vertical or overhead welding.

In spite of these limitations, the Aircomatic process (under suitable conditions) is definitely more economical than metallic arc welding on mild steel. The increased material cost of the welds can partly be offset by the increased operating efficiency of the process, through the absence of electrode changing and slag removal operations. However, this increase, by itself, gives the Aircomatic only a slight margin of between 5 and 15% over the metallic arc process. The great compensating factor is the increased welding speed, with its consequent savings in labor costs and time. Under proper conditions, this increased speed can offset the higher material cost of the Aircomatic welds, and can also provide savings as compared with stick electrodes.

See story next page ▶

Process that speeds a quality weld

Aircomatic is now firmly established as a method for the production welding of aluminum alloys, copper alloys and stainless steels, particularly in the heavier gauges.

Not nearly so well known is the fact that this inert gas shielded arc process also can be successfully employed for the welding of mild steels. Although the field of application is more restricted, within certain limitations the process can achieve definite and considerable economies over standard manual metallic arc welding.

The setup used for mild steel is the same as that employed on the other metals. It consists of a standard dc welding machine, argon gas supply and the Aircomatic unit itself—a portable carriage on which is mounted the coiled filler wire (mild steel in this case), the controls and an electric motor to feed the filler wire to the pistol-like torch or "gun." The operator simply points the gun at the joint to be welded and an electric arc is maintained between the automatically fed filler wire and the base metal. The filler wire is continually consumed as it is fused with the base metal to become the weld deposit, while the weld zone is protected against harmful oxidation by a blanket of argon gas issuing from the nozzle of the gun. In mild steel welding, 1-5% oxygen is added to the 99.9% pure argon (Canadian Liquid Air Co. Ltd.) in order to eliminate any possible tendency toward undercutting.

The recommended and most desirable conditions under which this method of welding mild steel will provide appreciable savings are:

(1) To make full use of its automatic features the welding operation should be of a production nature or be repetitive enough to keep the unit in almost continuous operation.

(2) Welding should be concentrated within an area that can be covered by the cable length or by carriage conveyance such as jib booms. In other words, welding should not be distributed in widely separated areas, where time would be lost from extensive movements of the carriage.

One Canadian company using the Aircomatic process for mild steel welding is Maritime Industries Limited of Sorel, Que. Last year, after extensive testing, they used the process on a large production order which involved extensive welded fabrication. When the order was completed, their estimated savings were fully confirmed and represented the very substantial cost reduction figure of 25%, as compared with standard metallic arc welding costs. These savings were achieved because the duty cycle of the units was maintained at a high rate within concentrated working areas and the work was properly positioned for horizontal or flat welding. Furthermore, with the sizes and types of weld involved on this production order, Marine Industries found the Aircomatic welding speeds on mild steel to be three times as fast as those possible with the metallic arc welding process.

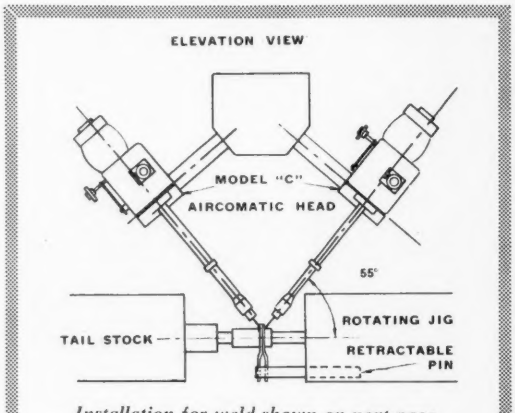
Toronto Coppersmithing Company Limited have used the method to fabricate a number of 600-gallon steam-jacketed kettles from stainless steel (19% Cr, 10% Ni, .08% C) with the inside bottom shell of pure nickel. The nickel was specified for its clean, long-wearing, corrosion-resistant qualities, along with its high heat-transferability.

The outer and inner shells were made in segments and the shells stress relieved after fabrication, with each shell hammered and annealed before assembly. The steam side of the inner nickel shell is mill finished for better heat transfer and therefore quicker cooking.

The outer stainless steel shells were welded with Type 308 rod and the inner shell with No. 61 nickel wire.

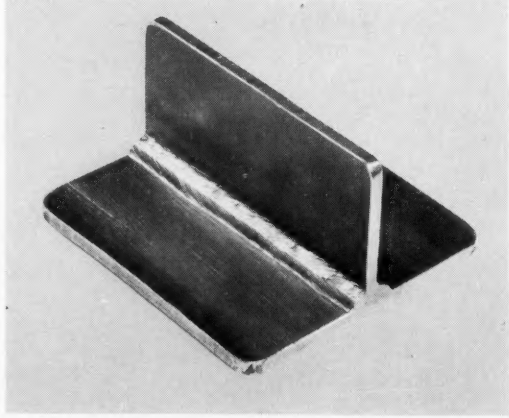
An outstanding example of automation in welding is underway at the plant of Beatty Bros. Ltd. in Fergus, Ont. This company won a contract from Chrysler of Canada to produce about a quarter of a million torsion bar suspension sub-assemblies designed for welding and identical in all respects, except that half were right-handed and half left-handed. One of the most important operations involved two circumferential fillet welds (of approximately 2¼ in. diameter) to join a stamped mild steel lever section to a cylindrical housing of 0.35% carbon steel material.

Realizing that the operation provided ideal circumstances for an automatic welding installation, Beatty Bros. Ltd. asked Canadian Liquid Air Co. to develop the necessary welding procedures and to recommend the welding equipment that would be required. ★



Installation for weld shown on next page.

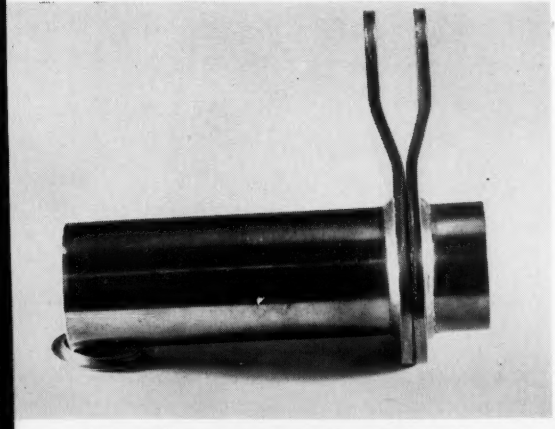
Welding should not be distributed in



Fillet welds of this quality are quite common on mild steel. Note neatness and absence of spatter and slag.

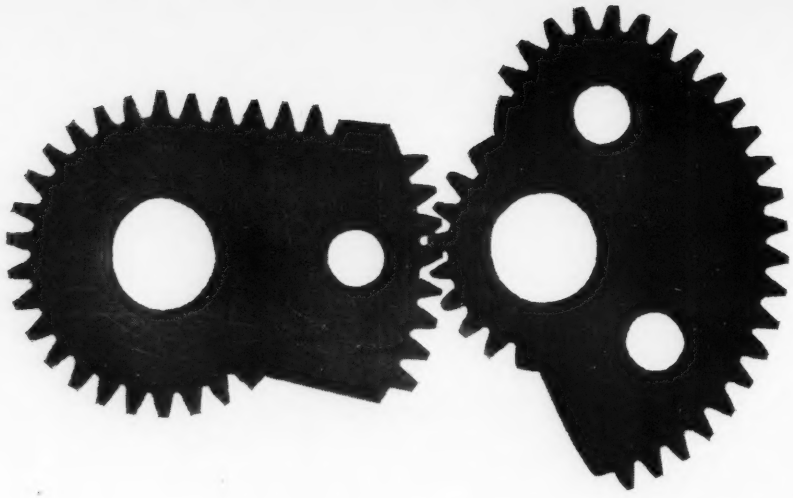
98% of the welding on this 16ft. diameter mild steel turntable for a dredge was done by two Aircomatic units.

widely separated areas as time is lost from much carriage movement



This welding operation is described in the text. Two circumferential fillet welds (approx. 2¼ in.

in diameter) were made to join a stamped mild steel lever section to a cylindrical housing of 0.35% carbon steel.



Design problems in non-circular gears

The basic principles, not generally known, are explained by the author

By W. H. Sheppard, AVRO AIRCRAFT LTD.

In the design of machinery or instruments it is sometimes necessary to vary the velocity ratio (or mechanical advantage) between two shafts by the use of gears. The basic principles, however, are not well-known and a thorough investigation was carried out by the writer, the results of which are given here.

Fig. 1 shows the pitch lines of two gears and a little consideration will show that the following principles must be observed:

1. The point of pitch line contact must always be in line with the centres of rotation of both members, to avoid toggle action. This also applies to rolling curves, not be confused with gear teeth which are sliding curves.
2. For continuous rotation there must be an integral (or integral fraction) velocity ratio. For example, a rounded square and rounded triangle would give a mean velocity ratio of 4/3. Identical gears give an average velocity ratio of 1/1, are interchangeable and have lower production costs.
3. The angle of obliquity of the common tangent at the pitch point must be low enough to avoid "pull-out". Theoretically this must be less than the complement of the pressure angle of the teeth used; in practice is much less. Conversely, for rolling curves a large angle is desirable to give a positive action and avoid large separating forces between the centres of rotation. In some cases it may be advantageous to change over from gears to rolling curves (or vice versa) as the angle of obliquity reaches a particular value (say 45 deg), but it will be realized that rolling curves are not reversible in action, unless loaded or connected by springs or links. If possible, gears should be mounted in a horizontal plane.

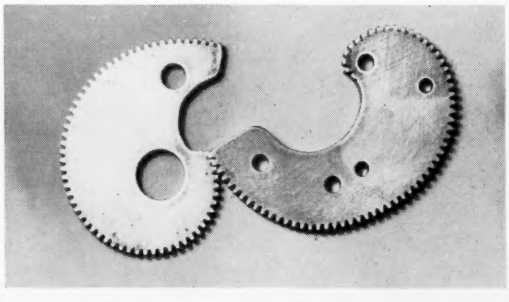
If practicable, the following principles should also be observed:

4. At least one of the members should be of recognized form (circle, ellipse or spiral).
5. Both gears should be identical.

In applying these principles it was found that practical problems could be classified in three groups as follows:

A. To design the follower to suit the driver.

Fig. 1 shows a practical method more suitable for large machinery such as steering mechanisms (Fig. 3), especially when the driver is of a recog-



nized form, in this case an eccentric circle. The pitch line of the driver is divided into equal short distances and the increment of radius measured at each point and subtracted from the radius of the follower, striking off a pitch line distance equal to those on the driver. This method is very suitable if further adjustment is required. For example, if two identical square-form gears are required, one can be drawn with the pitch line radius increasing and decreasing sinusoidally and the other to suit. Then both can be adjusted until they are identical. Cast gears of this nature were once made for crushing machines, to give a sliding motion between the rollers. A rounded-square form of gear was also designed for driving the platten of a continuously acting printing machine.

The theoretical method, more suitable for instrument work, is as follows:

Let $a = f(\theta)$ be the polar equation of the driver.
Inclination of tangent

$$\frac{da}{ad\theta} = \frac{f'\theta}{a}.$$

Inclination of tangent of follower

$$\frac{db}{bd\phi} = -\frac{f'(\theta)}{(s-b)}$$

whence

$$\phi = -\int \frac{(s-b)}{bf'(\theta)}\,db$$

and then "b" can usually be determined in terms of ϕ.
Example:
Let

$$a = Ae^{n\theta}$$

$$\phi = -\int \frac{(s-b)}{bnAe^{n\phi}}$$

$$= -\frac{1}{n}\int \frac{db}{b}$$

$$= -\frac{1}{n}(\log b + c)$$

$\phi = 0,\ b = B,\ c = -\log B.$
Therefore $b = Be^{-\phi n}.$

This is referred to the outer end of follower; if referred to the inner end, however, it can be shown that $b = Be^{\phi n}$, similar to driver. If $A = B$, gears are identical and $s = A(e^{2\pi n} + 1)$. Alternatively, this type of problem can be treated as explained more fully in the next section.
The velocity ratio

$$V = \frac{s-a}{a}$$

and

$$\phi = \int \frac{1}{V}d\theta = \int \frac{a}{s-a}\,d\theta.$$

In the above example

$$\phi = \int \frac{Ae^{n\theta}}{s - Ae^{n\theta}}$$

$$= -\frac{1}{n}[\log(s - Ae^{n\theta}) + c]$$

$$= -\frac{1}{n}[\log(s-a) + c]$$

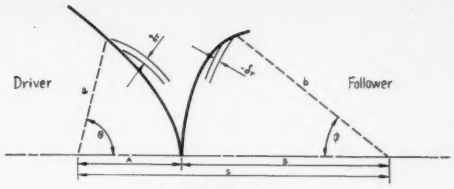


Figure 1

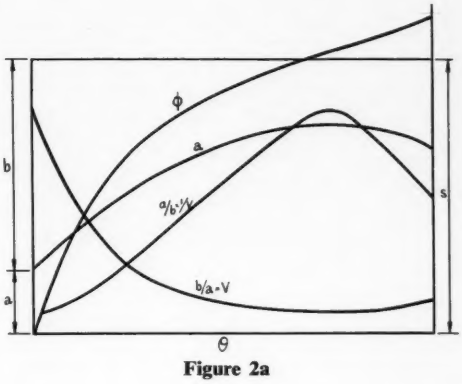


Figure 2a

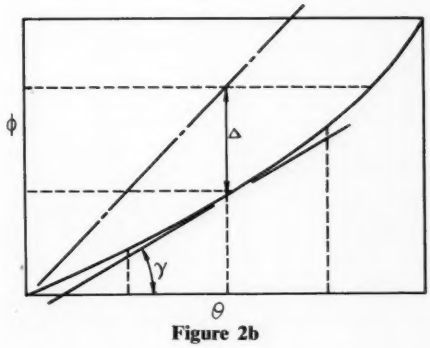


Figure 2b

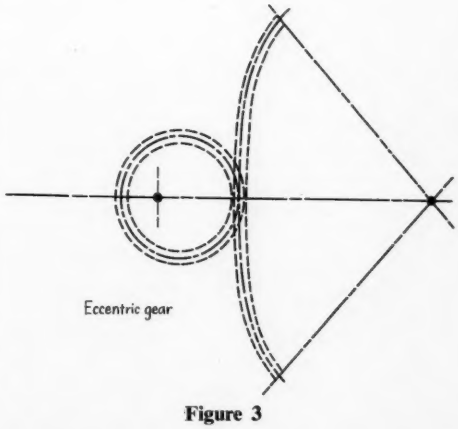


Figure 3

$\phi = 0, a = A, c = -\log(s - A)$

$$\phi = \log \frac{s - A}{s - a} = \log \frac{B}{b}$$

and

$$b = Be^{-\phi n}$$ as before.

A graphical method, based on the theoretical, and very suitable when the latter cannot be integrated, is as follows:

First plot "a" against θ in rectangular co-ordinates, as shown in Fig. 2(a). Then b is indicated as the difference between a and s. Next plot $1/V = a/b$ against θ and integrate in steps to give a curve of ϕ against θ. Then "b" can be read off for corresponding values of ϕ, in convenient steps of 10 or 15 deg of the latter.

B. To design a pair of gears to a particular velocity ratio.

In this case it is usually preferable to determine the relation between θ and ϕ

since $$ad\theta = bd\phi$$

$$\phi = \int \frac{1}{V} d\theta .$$

Then ϕ can be calculated and thence b in terms of ϕ.

Example:

$$V = \cos\theta$$

$$\phi = \int \sec\theta d\theta$$

$$= \frac{1}{2} \log \frac{1 + \sin\theta}{1 - \sin\theta}$$

$$= \frac{1}{2} \log \frac{a + \sqrt{a^2 - b^2}}{a - \sqrt{a^2 - b^2}}$$

$$= \frac{1}{2} \log \frac{s - b + \sqrt{s(s - 2b)}}{s - b - \sqrt{s(s - 2b)}}$$

$$= \log \frac{s + \sqrt{s(s - 2b)}}{s - \sqrt{s(s - 2b)}} .$$

Whence

$$b = \frac{2\epsilon^{\phi}}{(1 + \epsilon^{\phi})^2} .$$

Alternatively, the problem can be treated as in the previous section

Let $V = f(\theta)$

$$a = \frac{s}{1 + f(\theta)}$$

$$\phi = s \int \frac{db}{b(s - b)f'(\theta)}$$

$$= s \int \frac{db}{b\sqrt{s(s - 2b)}}$$

$$= \log \frac{s + \sqrt{s(s - 2b)}}{s - \sqrt{s(s - 2b)}}$$ as before.

In this case a graphical solution can be obtained by plotting $V(= b/a)$ and $1/V$ against θ and integrating the latter to give ϕ. Then

$$a = \frac{s}{1 - V}$$

for corresponding values of θ and

$$b = \frac{s}{1 - 1/V}$$

for corresponding values of ϕ. The graphs are shown also in Fig. 2(a).

C. To design a pair of gears for a particular displacement function.

In this case it will be realized that, if the gears are interchanged, the function will be the inverse of the original and therefore the follower can be determined in the same manner as the driver, using the inverse function.

Let $\phi = f(\theta)$

$$V = \frac{1}{f'(\theta)}$$

$$a = \frac{s}{1 + \dfrac{1}{f(\theta)}} .$$

Similarly $\theta = F(\phi)$

$1/V = 1/F(\phi)$ or $f'(\theta)$

$$b = \frac{s}{1 + 1/F(\phi)} .$$

Example:

Let $\phi = \log\theta, \quad \dfrac{d\phi}{d\theta} = \dfrac{1}{\theta}$

Photographs in this article appear through the courtesy of Fuller Electric Ltd., Williams & Wilson Ltd. and York Gears Ltd. to whom Design Engineering is indebted.

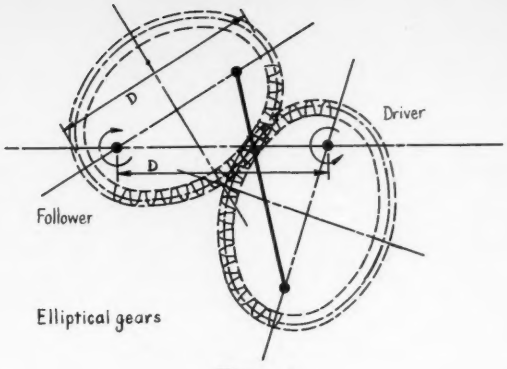


Figure 4

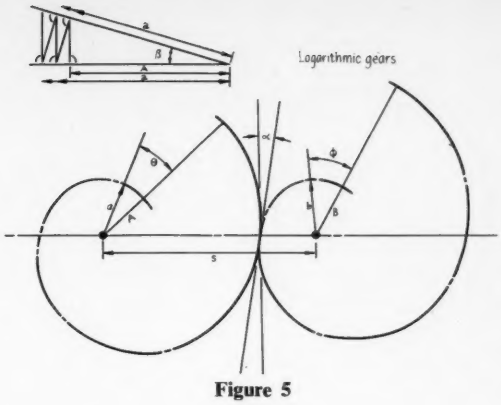


Figure 5

$$a = \frac{s}{1+\theta}.$$

Conversely, $\theta = \epsilon^{\phi}$

$$\frac{d\theta}{d\phi} = \epsilon^{\phi} (\text{or } \theta, \text{ whence } 1/V = \epsilon^{-\phi})$$

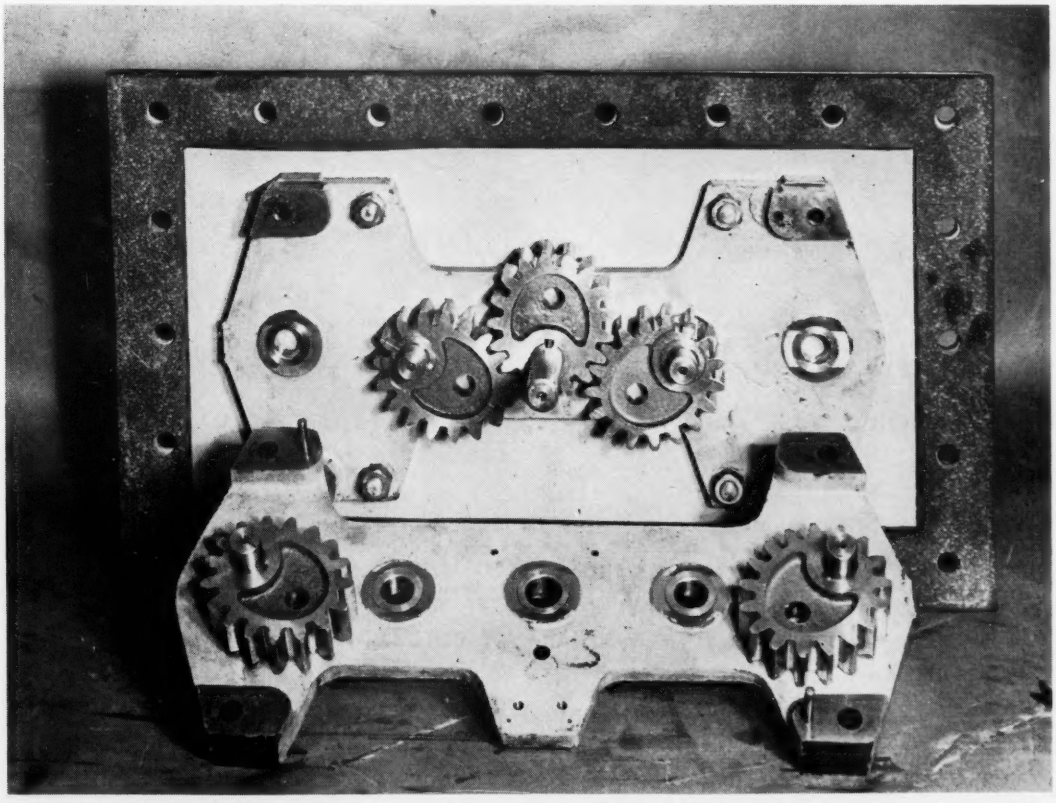
$$b = \frac{s}{1+\epsilon^{-\phi}}.$$

These gears can, of course, be used for adding logarithms through differential mechanisms to give logarithms of products. Several examples of these were also worked out by the previous methods, giving the same result but with much more work involved. The graphical solution in this case is shown in Fig. 2(b). ϕ is first plotted against θ. The value of V is given by cot γ and this can be read off in intervals of 10 or 15 deg of θ whence

$$a = \frac{s}{1+\cot\gamma}.$$

Similarly values of ϕ can be taken and γ read off. If referred to the horizontal axis

$$b = \frac{s}{1+\tan\gamma}.$$



Selector switches of the eccentrically operated rotary type using an elliptical gear drive in continuous mesh.

This construction might be used for a mechanism to convert siderial to solar time, the difference or "equation of time" being the increment or decrement.

Lengths of curves. In designing one gear to suit another, the periphery of the follower should equal that of the driver.
Theoretically

$$S = \int \sqrt{a^2 + \left(\frac{da}{d\theta}\right)^2} d\theta$$
$$= \int \sqrt{b^2 + \left(\frac{db}{d\phi}\right)^2} d\phi.$$

If the expression cannot be integrated, the lengths must be stepped out as in Fig. 1.

An interesting case occurs in the logarithmic spiral $a = Ae^{n\theta}$.

In this case, after integrating

$$S = \frac{\sqrt{1 + n^2}}{n}(a - A)$$
$$= \frac{\sqrt{1 + n^2}}{n}(B - b).$$

Since, as discussed later, $n = \tan \alpha$ then $S = \Delta \operatorname{cosec} \alpha$ where Δ = increase or decrease in radius. Thus the curve and arc may be regarded as a "bent" triangle of angle α. It can also be shown that for this curve, the radius of curvature ρ is equal to $r \sec \alpha$.

(NOTE: A common mistake is to regard dS as $ad\theta$ or $bd\phi$. This can lead to considerable error.)

Eccentric gears. Fig. 3 shows an eccentric gear in mesh with an approximately quadrantial rack. This was an old application in the steering gears of ships to give a greater mechanical advantage as the rudder moves from neutral position and experiences greater water pressure. In this case a standard circular gear with an eccentric boss can be used and the rack cut to suit. Theoretically, if the rack were a rounded square, continuous rotation would be obtained.

Elliptical gears. These have the advantage that they can be made identical, have recognized forms, give continuous rotation, and have a symmetrical velocity ratio curve. A modern application is in the actuation of aircraft servo tabs where, conversely to that of ships, the function is to give a greater velocity ratio during manoeuvres. In this case the rotation is not continuous but full use is made of the peripheries. Elliptical gears have also been used in planing machines to give a quick-return motion.

If two ellipses are mounted each at one of their foci, with centre distance equal to their major diameter, they will mesh perfectly, for as one radius increases, the other decreases in accordance with a well known principle. This fulfills condition 1 and agrees with the geometric theorem that both radii make equal angles with the tangent. Considering one gear, if the distance between the foci is ⅓ the major diameter (D), then the minor diameter (d) is equal to 0.943 D and the velocity ratio changes from ½ to 2, an increase of 1 to 4. Thus, with gears approximately circular, there is a large increase of velocity ratio without danger of pull-out. Since these gears at first sight appear circular, they are often erroneously referred to as eccentric.

If ellipses with greater eccentricity are used, pull-out can be avoided by a link joining the free foci, as shown in Fig. 4, thus combining the advantages of linkwork and elliptical gearing. Actually, continuous rotation could be obtained (without links) in one direction with teeth on one half of each ellipse as actually drawn in Fig. 4 but extended to reach over the dead centres, the rest being smooth curves along the pitch lines. With links, teeth are only necessary at the dead centres. It should also be realized that it is possible to have internal elliptical gears, connected if required by open links. In either case the formula $ad\theta = bd\phi$ applies to both gearing and link-work.

Actually it is possible to have two oval gears each mounted centrally, but they cannot be true ellipses. Two distorted eccentric circles can also be used if desired.

Logarithmic gears. These are shown in Fig. 5 but might more appropriately be called "exponential" gears. They have the advantage that they are of recognized form and can (if desired) be made identical. They give an increasing velocity ratio but not continuous rotation. They have the advantage that the angle of obliquity α of the tangent is constant, tending to give a smooth action.

In this case

$$a = Ae^{\theta \tan \alpha} \quad \text{and} \quad \theta = \cot \alpha \log a/A$$
$$b = Be^{\phi \tan \alpha} \quad \text{and} \quad \phi = \cot \alpha \log b/B.$$

For identical gears $B = A$ as mentioned previously.

Fig. 5(a) shows how the radii can be determined graphically. If the angle β is made such that $1/\beta \log \cos \beta = \tan \alpha$ the radii for consecutive positions can be determined by perpendiculars as shown. On the other hand, if α is made any other angle (such as 10 or 15 deg), the radii can be determined by the lines (not perpendicular) equally inclined to the radii. In either case these lines can be applied, if desired, to the actual radii in lieu of the auxiliary figure whereupon isosceles triangles for approximation by circular arcs can be obtained by bisecting the obtuse angles between adjacent lines. It should be clearly understood that these gears do not give a logarithmic (or exponential)

Continued on page 96

Cermets

Materials that stand up when the heat's on

Complex shapes that can be made in carbide materials.

The need for turbine materials has led to the use of the two basic cermets

Cermet developments

Over the past decade or two, many compositions, both metallic and non-metallic, have been investigated. The ultimate goal of these investigations was to develop materials with better high temperature properties in most cases, the need for turbine blade material being the driving force.

Many interesting compositions have been discovered, but only two basic types of cermets have survived the flood of cermet compositions that are available in experimental quantities. These two have gone on to become production materials capable of sustaining themselves in today's competitive markets. They are: (1) chromium (or chromium-molybdenum alloy) bonded aluminum oxide and (2) nickel alloy bonded titanium carbide. These cermets are finding wide application in fields where high temperature, wear, oxidation, corrosion, thermal shock and erosion are problems, and most certainly under conditions where high temperature strength is required.

Until recently, acceptance of cermet materials has been slow, but designers and manufacturer-users now know that if sufficient effort is made (and designs are modified to accommodate these cermet materials) success usually results.

By J. Wambold & T. F. Frangos

KENNAMETAL INC. HAYNES STELLITE CO.

Cermets as a class are low-ductility materials and must be considered as such in design calculations, but this fact should always be tempered with the thought that higher temperature resistant materials are certain to be less ductile than the commonly called super-alloys. This is borne out by the results of much recent metallurgical research in the high-temperature field. Where ductile, high-strength, high-temperature materials are available, they usually have insufficient oxidation resistance to be used in the majority of applications. So again the designer is called upon to overcome some of the difficulties that the materials engineer is still trying desperately to eliminate.

Possibly the most noteworthy case of designing for a particular material was that accomplished by the National Advisory Committee for Aeronautics. This organization (whose partial function concerns studies for advanced aircraft) was able (through design) satisfactorily to utilize a cermet material for rotating turbine blades. Since this time, of course, improvements in material have simplified the design problems somewhat.

Probably the two best-known production cermets are Haynes LT-1 (a chromium-alumina material) and Kentanium (a series of cemented titanium carbides produced by Kennametal Inc.). However, other manufacturers (such as Thompson Products, Carboloy, Firth-Sterling, Norton, Carborundum and various Universities and Industrial Research Laboratories) are unable to

Table 1. Chemical composition of various cermets

	Al	Co	Cr	Fe	Mo	Ni	Other	Balance
Borolite IV			56		14			Cr_2B
FS 27						50		TiC
K163B1					6.7	33.3		TiC
K183A	2.5		2.5		3	32		TiC
K184B	3		3		4	40		TiC
LT-1			77					Al_2O_3
608						15	2 WC	Cr_2C_3
TC 66 I			4	4		38		TiC
WZ 12 C		10	10			30		TiC
WZ 12 D		13	13			39		TiC

TiC roller bearing for unlubricated service at 1200F.

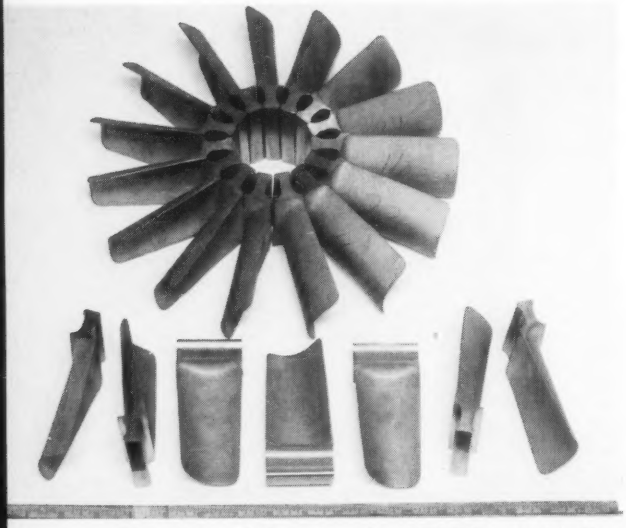
supply numerous types of cermets, at least in experimental quantities. This article will in general touch mainly on the production materials, but some properties of a number of materials are shown. The chemical composition of various cermets is shown in Table 1.

The chromium-aluminum oxide cermet depends on the formation of an intermediate bond between the metal and ceramic phases, probably a physical-chemical bond based on the sharing of oxygen atoms by both the chromium and the aluminum. This may be a spinel type of structure. There is no indication of wetting or solution.

The general nature of the constituents show up in the combinations. Chromium-aluminum oxide cermets are oxidation resistant, because of the formation of a tightly bonded layer of chromium oxide on the surface. This layer is chemically inert and protects the interior from further attack. Haynes LT-1 material is formed by the ceramic technique of slip casting, so that intricate and hollow shapes are rather easily formed. Other cermets of this type have used hydrostatic pressing as a means of shaping and forming. Regardless of the forming process, the material must be sintered in order to densify the shape. After sintering, the LT-1 can be machined with standard tungsten carbide tools, if care is taken to avoid chipping.

Some modications of the chromium-aluminum oxide material have been studied and it has been determined that a chromium-molybdenum alloy binder phase will greatly increase the strength of this cermet at room

"Cermet materials may be tailor-made for future nuclear applications"



These rotor blades are made of K162B material. Note that they have a specially designed root section.

Table 2. Physical Properties of various cermets

	Density (lb/cu. in.)	Modulus of Elasticity (psi x 10^{-6})		Thermal Expansion (in/in/deg F x 10^{6})	Hardness
		Room temp.	1,500F		
Borolite IV	.258	—	—	—	RA 80
FS 27	.236	51	—	6.1	—
K163B1	.228	55	46	5.4	RA 86
K183A	.224	50	40	5.6	RA 87
K184B	.228	50	41	6.0	RA 85
LT-1	.210	42	—	4.7	RC 36
608	.252	—	—	6.4	RA 88
TC 66 I	.236	—	37	6.0	RC 57
WZ 12 C	.238	51	43	5.5	RA 81
WZ 12 D	2.49	46	—	5.9	RA 76

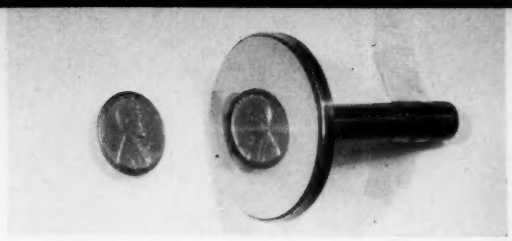
and elevated temperatures. The thermal shock resistance of the chromium-molybdenum modification is also improved over the straight chromium bonded material.

Titanium carbide cermets are a derivative of tungsten carbide cutting tools and thus belong to the family of cemented carbides. The so-called cementing is obtained by the action of nickel (or nickel alloys) bonding with the titanium carbide particles during the application of heat. Titanium carbide cermets are formed by powder metallurgical techniques and sintered in order to densify the pressed shapes. Kentanium is formed by the unique process of explosive pressing, whereby the forces produced by igniting gun powder in a closed chamber are used to transmit equal pressure to all sides of the shape. The shock wave produced by the explosion also aids considerably in obtaining better pressing.

After sintering, the titanium carbide materials must be ground to tolerances closer than 1.0%. However, machining can be accomplished in the pre-sintered condition, and so grinding can be kept to a minimum on complicated shapes.

Original compositions of metal bonded titanium carbide used nickel as the binder phase, but over the years, nickel alloys (when used instead of nickel as the binder) have shown marked improvement in all physical and mechanical properties. The most recent binder composition is a nickel, chromium, aluminum and molybdenum alloy which exhibits extremely high strength at elevated temperatures, along with improved toughness and oxidation resistance over other alloy binders.

Generally speaking, cermet compositions have a lower density than the super-alloys used for elevated temperature service. Likewise, the thermal conductivities and elastic modulii are higher, whilst the thermal expansions are lower. Table 2 lists miscellaneous physical properties of various cermet materials. The mechanical properties of the various cermets (Table 3) are limited in the case of certain materials.



Carbide integrator disc has a very high surface finish.

It should be noted that the impact strength of cermet materials has always been the subject of much discussion, both on the design level and also in the material laboratories. Considerable work has been undertaken in order to arrive at a satisfactory method of measuring impact strength and as yet no standard has been adopted. Kennametal Inc. has adopted a method which has proved itself to be of considerable value for composition development and the measurement of apparent impact strength. The method itself is not new, but its adaptation to cermet materials is very helpful for laboratory evaluation work. The method consists essentially of measuring the area under the stress-strain curve and reporting the values as a toughness number (see footnote to Table 3). This tensile type test correlates very well with impact results, is more reliable and has fewer variables than impact tests.

Thermal fatigue is a property that is becoming increasingly important as operating temperatures increase. One large aircraft engine manufacturer has conducted a thermal fatigue test (a thermal shock test, as it is commonly called) on various cermets. This test consisted of 100 cycles at each 100 F increment of temperature, from 1800 F up to 2200F. A bending stress of 7900 psi was applied to an airfoil shaped specimen to simulate the load that would be imposed during service. Results were reported based on the number of cycles and the amount of bow in the specimen after each temperature level. Certain of the materials exposed to the above test are mentioned in Table 4.

Table 3. Mechanical properties of various cermets

	Tensile strength (ksi) and elongation			Modulus of Rupture (ksi)			100 hr Rupture strength (ksi)			Fatigue strength (ksi)		
	R.T.	1,800 F	2,000 F	R.T.	1,500 F	2,400 F	1,600 F	1,800 F	2,000 F	R.T.	1,600 F	1,800 F
Borolite IV	—	—	—	—	—	—	—	41	16	—	—	—
FS 27	75	—	—	—	—	—	—	9.3	—	—	—	—
K163B1	113(.23)	46(.70)	—	236	—	—	31	12	—	82.5	39	21
K183A	104(.20)	72(.68)	45	184	—	—	45	28	6	—	—	—
K184B	134(.32)	54(.74)	—	193	—	—	38.5	13.5	—	83.5	35	20
LT-1	38	—	—	45	43	9	—	—	—	—	—	—
608	—	—	—	—	—	—	—	3.5	—	—	—	—
TC 66 I	50	—	—	—	—	—	40	15.5	—	—	—	—
WZ 12 C	127	46	24	202	130	—	31	15	—	—	—	—
WZ 12 D	142	40	—	208	125	—	25	11	—	—	—	—

Toughness Number: K163B1 = 147 at room temp. 278 at 1,800 F.
K183A = 106 at room temp. 385 at 1,800 F.
K184 = 226 at room temp. 297 at 1,800 F.
Cast iron = 75 at room temp.

Cermets are being thoroughly investigated for wear applications in the belief that the combination of a wear-resistant non-metallic phase in a tough metal binder will result in good wear resistance. Results depend on the materials. Tungsten carbide (with a binder) is excellent under conditions of sliding friction, abrasion and erosion, such as encountered in a sand blast. The chromium-aluminum oxide cermet shows better resistance to sliding friction and to erosion by fine particles, such as in catalytic refiners. This resistance is more significant at elevated temperatures, where the susceptibility to failure becomes more pronounced.

In general the chromium-aluminum oxide cermets are suited for use in applications where oxidizing conditions exist, at elevated temperatures and where impact is not a problem. This material (along with other cermets) is being evaluated for seal rings, furnace parts and fixtures, melting pot components (where resistance to wetting is important) and as burner parts where oxidation and thermal shock causes failure of pure oxide ceramics. Brazing fixtures (where resistance to wetting is desirable) is another field of application for the oxide-type cermet. Probably the most successful application of the LT-1 material is for thermocouple protection tubes, where the combination of high thermal conductivity, oxidation resistance and strength are desirable. The fact that the tubes can readily be cast to shape in lengths up to 42 in. is also important. These tubes offer quick temperature response, greater sensitivity and withstand more severe temperatures and corrosion.

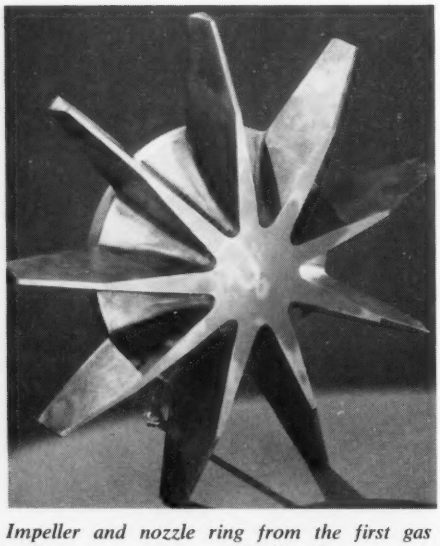
Titanium carbide materials are undergoing tests and evaluation in a wide range of applications, from turbine wheels that operate in atmospheres approaching 3000 F to wear applications at room temperature. Some of the most interesting recent applications involve unlubricated bearings operating up to 1500 F, various temperature-sensing devices operating on the differential expansion principle, seal rings, high temperature wear parts, one-piece turbine wheels, structures requiring maximum rigidity and various short-time high-temperature components for aircraft and missiles.

Table 4. Thermal Shock Resistance of various cermets

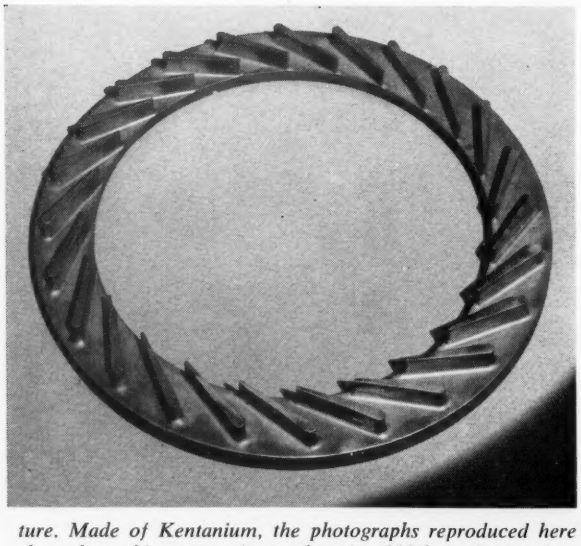
Material	Total cycles	Failure temperature	Bow at 2,000 F
K163B1	550	No failure at 2,200 F	0.00 in.
TC 66 I	550	No failure at 2,200 F	0.03 in.
WZ 12 C	488	Failed at 2,200 F	0.00 in.
FS 27	No failure at 2,000 F—test discontinued due to excessive bow		0.20 in.
K175B	262	Failed at 2,000 F	
Cr-Al_2O_3 (Ohio State)	234	Failed at 2,000 F	

Since the advent of the nuclear age, requirements for reactor materials cannot be evaluated in every laboratory. The builder of a nuclear power plant must (at least in some cases) take what he can in the way of material and sometimes may not know whether he is using the best available. Cermets as a class are materials that can be fabricated to meet special requirements by mixing desirable ingredients together, as it were. No doubt this is an over simplification of the problems but there is every reason to believe that, in the future, cermet materials will be more or less tailor-made for nuclear applications. At the present time, however, only a few cermets have been considered for use in reactors.

"Regardless of the forming process, the material must be sintered"



Impeller and nozzle ring from the first gas turbine to operate at 1900F inlet temperature. Made of Kentanium, the photographs reproduced here show the turbine parts after undergoing 100 hrs. of operation.



The how and why of temperature control

High quality components don't make the control system. There are many other factors playing their part

By Douglas T. King FENWAL INCORPORATED

The choice of high-quality components does not, of itself, assure good temperature control in a heated system. The control precision is influenced largely by many other factors. Relative positions of thermostat, heater and temperature-controlled area to be used by the operator, degree of heat balance and thermal characteristics of the materials making up the apparatus all play a part (and a large part) in affecting the accuracy of control that will be obtained.

As a manufacturer of precision temperature controllers and overheat detectors, this firm has devoted considerable research into the basic fundamentals of temperature control. In order that you, the designer, may benefit from these basic studies, this article will discuss some of the major factors that affect the design of a temperature-controlled system and will describe some of the more common types of controller, in order that you may better understand where each can be best applied.

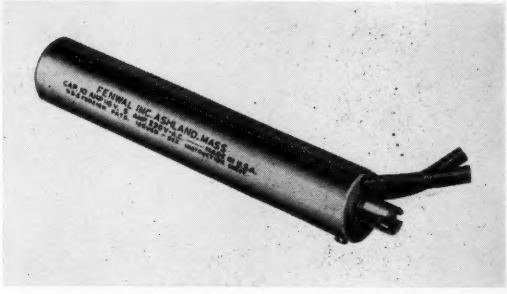
First, a few basic definitions. In any discussion on the accuracy of temperature control, three terms will frequently be encountered. These are: Controller resolution sensitivity; Controller operating differential; Process system bandwidth (see Box and Fig. 2).

Many different types of temperature controller are available for the designer to choose from. Some of these are pictured here. They range from tiny compact units (particularly suitable where space is at a premium and weight must be considered) up to elaborate electronic types for location at great distances from the system to be controlled.

TABLE 1 — Typical Relative Thermal Properties of Materials

Material	Thermal diffusivity	Thermal conductivity
Silver	6.5	242
Copper	4.4	224
Aluminum	3.1	117
Brass	1.2	60
Iron	0.7	39
Stainless steel (416)	0.19	14
Stainless steel (18-8)	0.16	9
Mica	0.009	0.3
Asbestos	0.004	0.1

NOTE: Actual values depend on temperature, exact composition and previous history of material.



1. A basic cartridge Thermoswitch. This differential-expansion thermostat is for local bulb applications.

The electrical current which can be carried by the various types of thermostat and temperature controller will vary considerably. In general, the smaller units are not capable of directly carrying as much current as the larger ones. Typical values would be 1 or 2 amps for the miniature and midget size, 10 amps for a cartridge size and up to 15 amps for the snap-acting-type local thermostat. Units such as the remotely adjustable, non-indicating type will operate satisfactorily at currents as high as 35 amps. The current limitation of the smaller types should not restrict their use, however, in those applications where they might otherwise be desirable. It is usually possible to incorporate a relay so that the thermostat controls only the relay coil, with the relay in turn controlling the higher value of electrical current, which would otherwise have exceeded the rating of the thermostat.

Before selecting one of the many temperature-control elements, the designer must give careful consideration to the nature of the system which is to be controlled.

Ideally, that portion of a system housing the temperature controller, the heat source and that part where the controlled temperature will be utilized, should be fabricated from materials with high heat conductivity, low density and low specific heat. Good conductivity in the temperature-controlled portion of the system is important in order to minimize temperature gradients and system inertia or the time required for the heat wave to travel throughout the material.

Too often overlooked, though, are the concepts of

Basic Definitions

Controller resolution sensitivity: Can be defined as the minimum temperature band required to cycle the electrical contacts of the controller. It is the inherent sensitivity of the controller itself, a measure of the minimum temperature change to which it can respond under the most favorable conditions. This can be thought of as a theoretical rather than a practical consideration, since it would be quite unusual for a practical process to incorporate a thermal system which changed temperature so slowly that it could be used to measure the inherent sensitivity of a thermostat.

Controller operating differential: Is the difference in temperature (measured at the outer surface of the temperature sensitive element) required to cause the contacts of the controller to open and close when the device is in control of a particular process. The distinction is that the operating differential refers to the actual performance of the device in a given temperature-controlled process. The operating differential of a controller will almost always be greater than its inherent sensitivity.

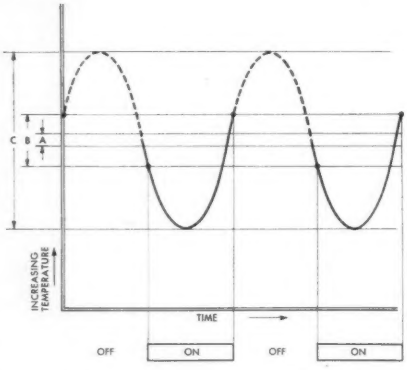


Figure 2.

Process system bandwidth: This is the difference between the maximum and minimum temperatures measured at a point in the thermal system which can be considered the useful working area. System bandwidth is an end measure of the practical temperature control which results in a given application. It is not merely a function of the operating differential of the thermostat, but is dependent on such characteristics of the system as the inertia of the heated components, relative location of heaters and controller, variations of heat requirements, heat balance and frequency of operation of the control element. The mean temperature (which is usually the temperature with which the designer is most intimately concerned) is a numerical average between the maximum and the minimum bandwidth temperatures.

light weight and low heat capacity. Weight and thermal capacity of the material directly influences the cost of operating the process, since they determine the quantity of heat required to raise the process temperature a given amount. The term "thermal diffusivity" (which is the ratio of conductivity divided by the product of density times specific heat) is a good measure of the comparative advantage of various materials used as heat exchange mediums. Diffusivity then is the heat conductivity of a material divided by the heat capacity per unit volume. Table 1 lists the relative diffusivity (or "speed") and thermal conductivity of several common materials.

When attempting to evaluate any temperature-controlled system, it must be recognized that, unlike most other measurables, temperature cannot be measured instantaneously. An appreciable time is always required for the temperature sensing element to approach the temperature of the surrounding medium. The use of a comparatively slow, mercury-in-glass thermometer or bulb-type temperature indicator to evaluate the control characteristics of the more sensitive types of primary element used with many temperature controllers can often be very misleading. This is particularly true in rapidly changing systems where the phase relationship between the temperature sensed by the controlling element and that sensed by the indicating element can be displaced by as much as 180 deg (angular). This makes it appear that the control element is adding heat to the process (after it has warmed up) and is cutting off heat from the process (after it has cooled down).

Fig. 3 illustrates temperature gradients which might be present in a relatively simple system during a given thermal cycle. The three curves are representative of temperatures which could be measured at the heater, at the thermostat and in that portion of the system which can be considered the useful working area. This set of curves demonstrates clearly that observation of temperature variations at a given point in the system does not provide a true picture of what is happening throughout the system. The temperature will always be highest near the heat source and will decrease at points progressively farther from the heater. Because of this (unless the temperature-controlling element is located very close to the useful working area) it may be necessary to adjust it to operate at a somewhat different temperature, since it does not sense the same absolute temperature as that which could be measured in the working area.

Even if a material with excellent thermal diffusivity characteristics (such as silver) is used for the heat exchange medium, a definite period will be required for a temperature change occurring in one part of the system to be transmitted to other parts. This thermal lag results in what is termed "temperature overshoot."

Whenever extremely narrow differential temperature control is necessary (and the choice of heat exchange medium is not fixed because of other factors), it is well to consider the relative advantages of different systems. As a general rule-of-thumb and not taking into account the individual properties of materials within a given class, the following list has been arranged in order of preference where close temperature control is required:

- Well-agitated liquids.
- Rapidly moving air.
- High diffusivity metals.
- Low diffusivity solids.
- Stagnant air.
- Stagnant liquids.

Well-circulated fluids can be used to provide closer temperature control than solids, only if the forced convection of the fluid is sufficient to overcome the inherent disadvantage in fluids namely:— poor conductivity and the slow rate of heat transfer resulting from normal convection.

In addition to the fundamental requirements of the heat exchange medium itself, it is equally important to insulate the heat transfer material from other sections of the equipment used primarily for mechanical support.

The basic location of the various components should be governed by the nature of the application, that is, whether static or dynamic. A static system is one in which the heat demand is practically constant. An example of a static system is an oven in which a certain quantity of material is placed for a reasonably long time, during which it must be controlled at a given temperature. Such a system will require an essentially constant heat input. A dynamic system is one in which the heat requirements vary appreciably. An example of a dynamic system is a plastic molding press into which are introduced cold charges, which must be rapidly brought up to curing temperature and held there for short periods.

Effects which can be obtained by varying the position of the heater and thermostat with respect to the load will be discussed in the following paragraphs. Fig. 4 shows some widely differing effects obtained from certain arrangements and includes the effect of adding thermal loads to the system.

Six arrangements

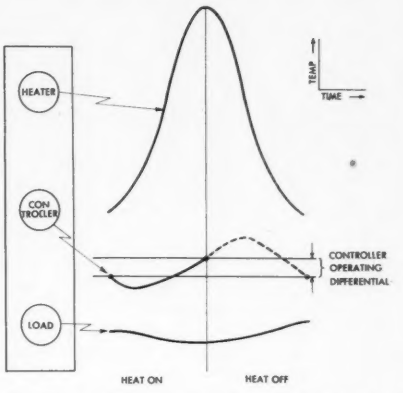
Arrangement 1: Heater distant from load, thermostat near heater (Fig. 4A). In a static system, placing the heater at a considerable distance from the load with the control element adjacent to the heater can result in excellent control in the vicinity of the load. The controller will respond very rapidly to temperature changes at the heater and will thus prevent any extreme temperature excursions near the load, by eliminating prolonged heating or cooling periods. Provided the heat demand at the load is constant, this arrangement permits the thermostat to control the useful portion of the system very accurately.

A further characteristic is that the controller will cycle quite rapidly. The relatively small amount of thermal lag between the controller and the heater, and the more extreme temperature gradients near the heater, cause the controller to respond more quickly. The service life of electrical contacts actuated by the thermostat can be reduced somewhat due to this rapid cycling.

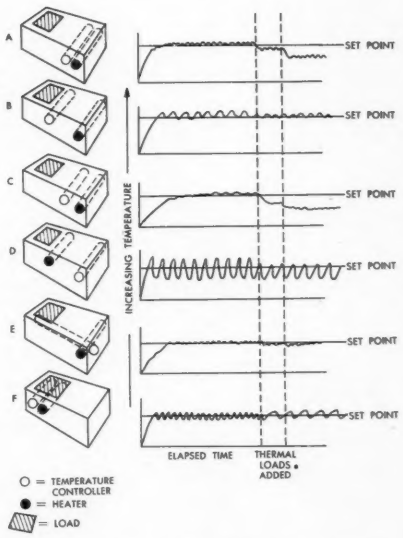
In a dynamic system, where the heat demand of the load may be continually changing, this arrangement would not give optimum control. Due to the lengthy heat-transfer path between the control element and the load, temperature changes in the vicinity of the load are not detected as readily. Accordingly, the temperature in the vicinity of the load can vary appreciably outside the desired limits.

Arrangement 2: Heater distant from load, thermostat at load (Fig. 4B). This arrangement (in a static system) will not provide the very narrow system temperature differential obtained with the arrangement of Fig. 4A. Due to the greater distance between the heater and thermostat, the heat wave cannot be transmitted as rapidly and this causes greater excursions of controlled temperature with a wider system band-width.

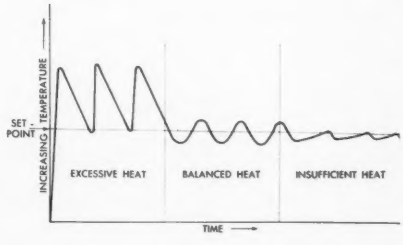
Gradients, different arrangements, three curves



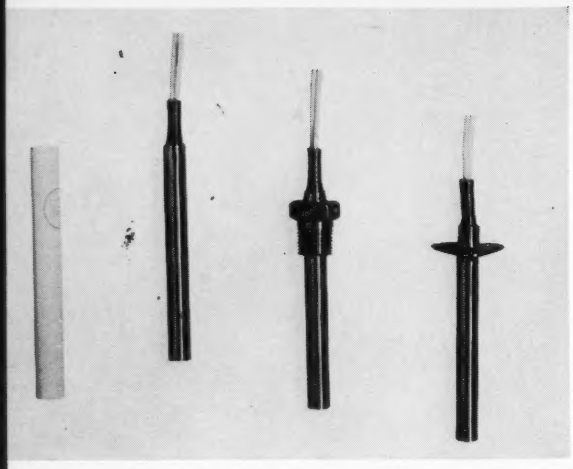
3. The temperature gradients which might be present in a relatively simple system.



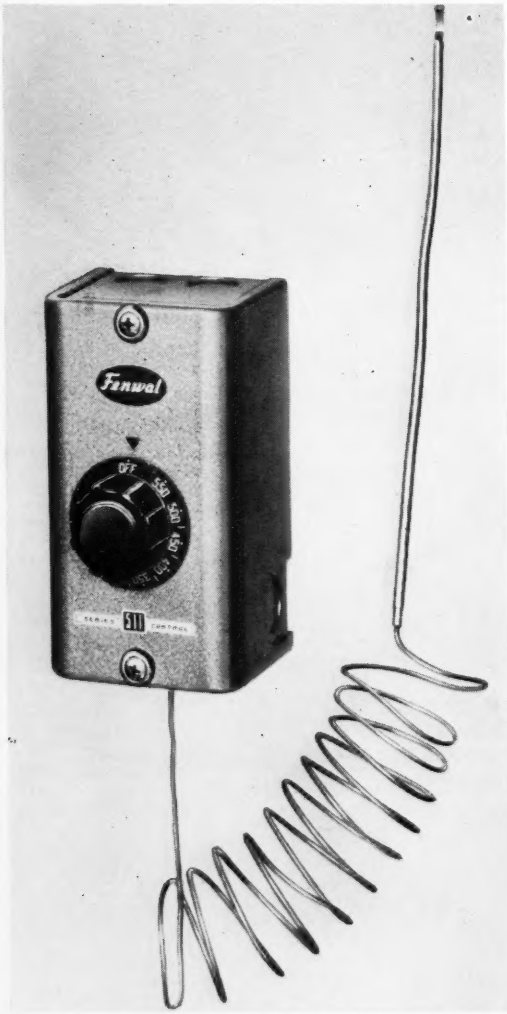
4. Six of the widely differing effects that can be obtained from certain arrangements.



5. These curves demonstrate the importance of correct balance in the thermal system.



6. Midget Thermoswitch units. Differential-expansion type thermostats for use in local bulb applications.



7. A liquid-filled bulb and capillary controller. For the applications requiring a remote setting feature.

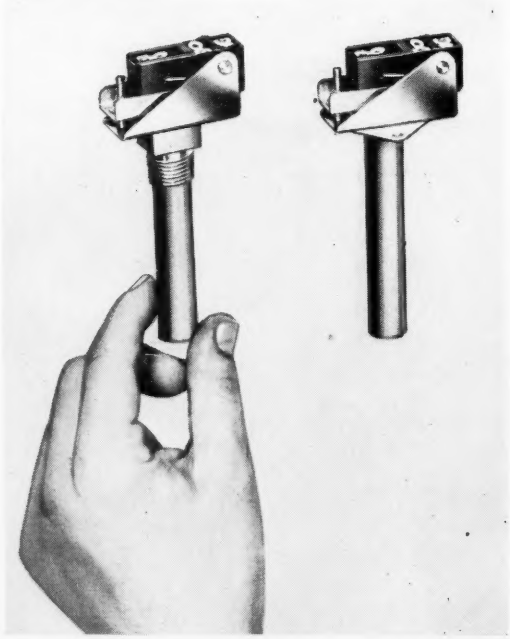
Temperature control continued

In a dynamic system, placing the thermostat closer to the load has definite advantages in that it can sense changes in heat requirements at the load in a minimum of time. While the system bandwidth may be rather wide (due to the time required to sense the action of the heater) the mean temperature at the load will remain relatively constant. Due to the ability of the thermostat to maintain a constant mean load temperature with this orientation, it can be preferable in a dynamic application. Since this arrangement produces a slower thermostat cycling rate, the service life of the temperature controller may be increased somewhat, thereby prolonging the useful life of all electrical components.

Arrangement 3: Thermostat midway between the heater and load (Fig. 4C). This arrangement may be considered as a compromise between the two extremes discussed previously. In certain cases it will be more satisfactory than either of them, since the thermostat is capable of sensing temperature changes either at the heater or at the load rather quickly.

Arrangement 4: Heater at load, thermostat distant (Fig. 4D). For obvious reasons, this arrangement will result in the poorest control of any that could be selected. With the thermostat remote from both the heater and the load, the maximum possible amount of thermal lag will be introduced between the controlling and the controlled elements. Consequently, the load will experience extreme overshoots and undershoots because the thermostat is not able to monitor the rapidly

"Temperature controllers range from



8. Liquid-filled Thermoswitch units. These are snap-action type thermostats for local bulb applications.

changing temperature conditions near the heater. With the thermostat located so far from the heater, the system cycling frequency will be reduced appreciably, further reducing accuracy of control.

Arrangement 5: Heater distant from load, thermostat extended between them (Fig. 4E). Due to the oversimplification of the first four hypothetical thermal systems, the general conclusions that were drawn would apply equally to all types of temperature sensitive elements. However, in selecting a particular temperature control element, it is important to recognize what portion of the device will respond to changes in temperature. Certain sensors inherently respond to changes in temperature at only a single point. This is particularly true of a thermocouple. Mercury and glass thermometers will also approximate this characteristic, due to the relatively small size of the temperature-sensitive bulb. However, many sensing elements that are used to actuate temperature controllers have the advantage that they can integrate temperatures over a substantially large section of their total volume. The liquid-filled bulbs of the controllers shown in Fig. 8 are good examples of this. The differential expansion type thermostats (in figures 1 and 6) act in much the same way, since the entire length of the outer shell forms the temperature sensing element.

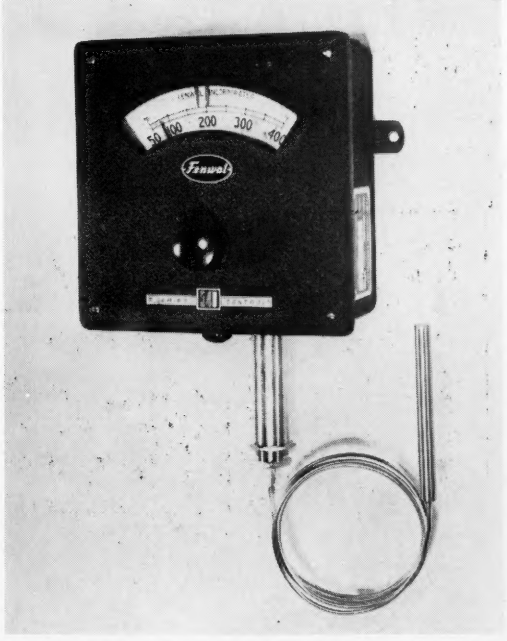
This ability of certain temperature controllers to respond to an average temperature (rather than to a temperature at a fixed point) makes possible an extremely useful application in the particular arrangement of Fig. 4E. By extending the temperature sensitive portion of the controller so that one portion is adjacent to the heater and another near the load, the unit will respond rapidly to temperature changes, either at the heater or at the working area. This can be particularly desirable in providing rapid system warm-up and a reasonably fast cycling rate.

Arrangement 6: Heater, thermostat and load, all in close proximity (Fig. 4F). The ideal control will be most nearly achieved if the heater and thermostat are placed in the immediate vicinity of the useful working area. With all components grouped closely together, the heat transfer path is short, so that the controller is not handicapped by any appreciable thermal lag. Also, because of the smaller mass of the conducting medium, the effects of inertia will be minimized. The system will cycle rapidly and the rate of recovery from thermal upsets will be fast. This arrangement is most suitable in installations where the thermal load changes frequently.

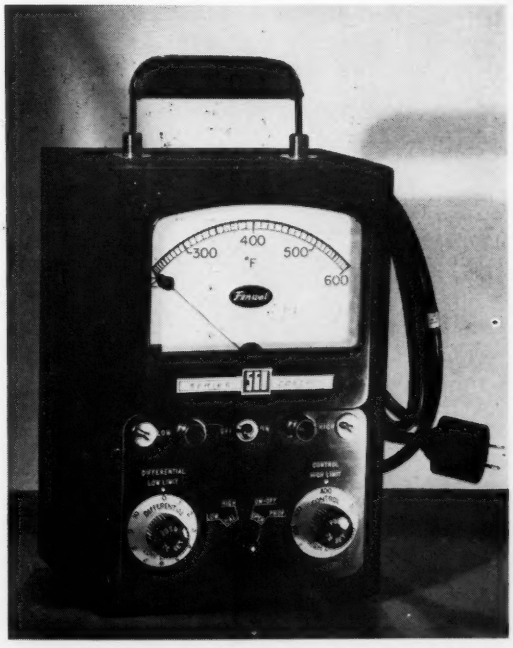
To summarize, then: With a static system, in which the heat requirements are comparatively constant, the closest temperature control can be obtained by placing the thermostat as close as possible to the heater, with the load at some greater distance. The ability of the thermostat to respond rapidly to temperature changes

Continued on page 90

tiny units up to elaborate electronic types placed at some distance"

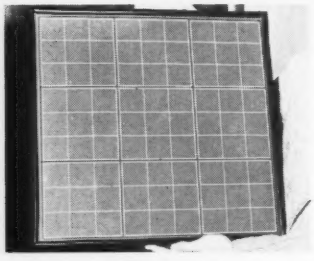


9. Liquid-filled and capillary controller for applications with remote setting and indicating features.



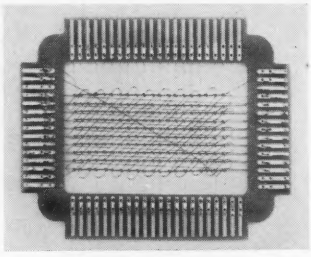
10. A thermistor actuated electronic controller for applications requiring remote setting and indication.

Design news in pictures



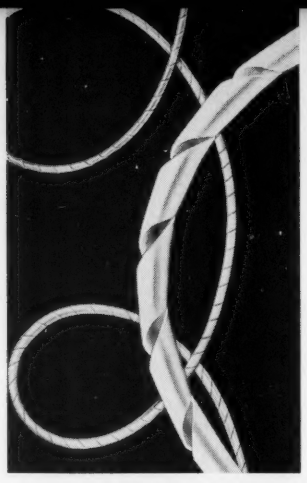
Sun current

An 18-in. square sun battery to convert solar energy to electrical current for a wide variety of applications. It consists of 6-in. square selenium cells. (200)



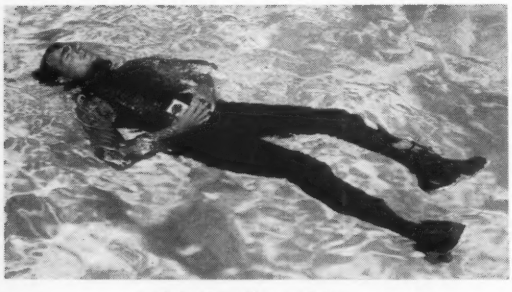
Brain's grey matter

Copper wires strung on a frame hold the tiny, doughnut shaped magnetic cores of ferrite which form the vital memory circuits of data processing systems. (201)



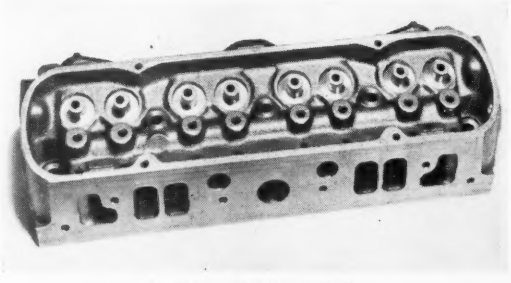
New twist in nylon

Spiral cut nylon tubing is now available for new design applications. Available in several outside diameters, it bundles diameters up to one inch. (202)



Salvation for a sinker

This new flight suit will float even an unconscious pilot face-up. It combines five protective suits in one three-piece garment and even the boots of the outfit float. This particular man modeled the suit because he normally floats about 6 in. under. (203)

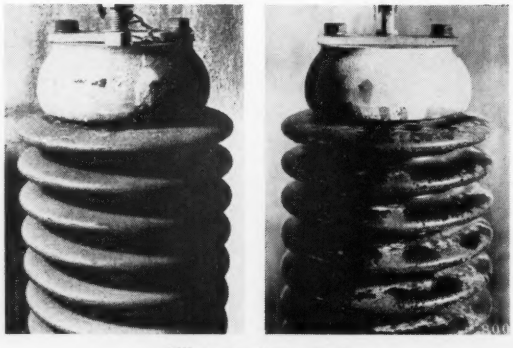


Fast work with a drill

Each of these eight 0.340 in. dia., 3 in. long valve guide bushings in this cast iron automotive cylinder head were drilled in 12 seconds with a carbide tipped pin cutting type drill. The holes are to a 0.0005 in. tolerance and a 15 microinch finish. (204)

Cool, real cool

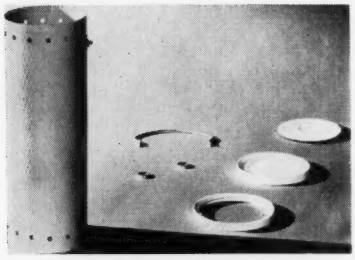
An air conditioner being used during pre-flight to cool the electronic equipment on a Douglas F4D Skyray. The seven-ton capacity air conditioner takes its power from an air cooled engine. The airflow may be used for both heating and cooling work. (205)



Silicones stop a leak

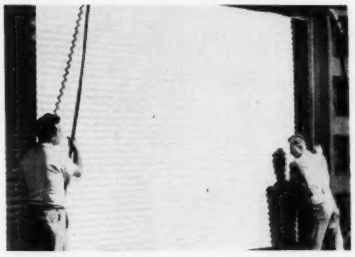
Laboratory tests on silicone-treated (left) and untreated insulators at 100% humidity. They confirmed that a problem of flashover in areas of high humidity could be cured by coating the insulators with a silicone compound which holds down leakage. (206)

Some modern designs making news today



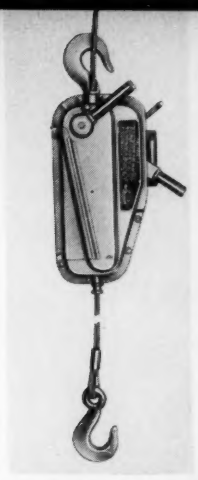
Assembly simplicity

Simplified design is a feature of these hampers. Vulcanized fibre body, top ring cover, styrene bottom and anodized aluminum carrying handle can be easily and quickly assembled. (207)



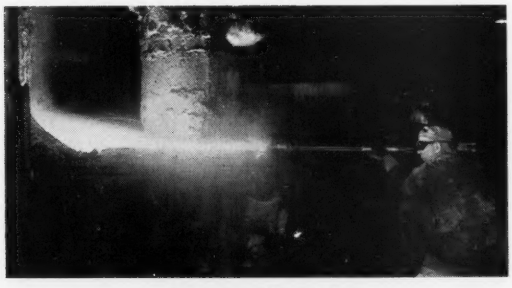
Corrugated and big

A large acrylic sheet being withdrawn from its forming press. Corrugated sheets up to 8½ ft x 10 ft in both colourless transparent and translucent colours are currently available. (208)



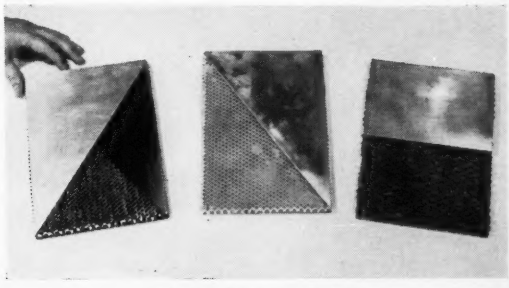
Mighty midget

The nominal power of this hoisting and traction device is 3,300 lb. its weight, 42 lb. (209)



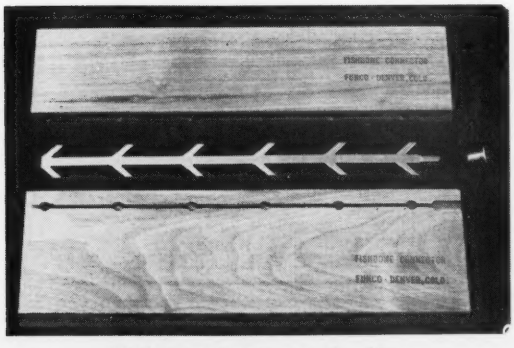
Blowpipe with a bite

This new blowpipe shown removing a large riser from a casting is unique in many respects. It is capable of cutting through steel as thick as 55 in. with a single pass. Instead of the conventional nozzle, a special head locates the nozzle out of centre. (210)



Filling for a sandwich

Three sandwich panels illustrate excellent adhesive bonding characteristics. The centre panel consists of an aluminum honeycomb core bonded on one side to an aluminum facing and on the other side to a glass facing. The bonders are 3M adhesives. (211)



Fishbone to fasten your furniture

One of the neatest ideas we've seen in a long time is this fishbone connector for knockdown furniture. The spine drops into slots in the pieces to be fastened and the female nut cap is then threaded on one end. This draws the surfaces firmly together. (212)

I always carry my own

This mechanical mantis is a mobile assault bridge launcher. It consists of a heavy-duty automatic hydraulic system mounted on an M-48 tank chassis to handle an aluminum bridge of either 40 ft. or 60 ft. length. It will support loads up to 60 tons. (213)

Ideas round-up

Power shovel: an emphasis on easy maintenance

A 1½ cu yd shovel (of completely new design and with all the latest features of power crane and shovel practice) has been introduced by **Dominion Engineering.**

Air controls are employed for all the main operating functions on both the top deck and the crawler. Graduated air control valves are used for the friction clutches and provide ease of operation with sensitive control over the load.

Throughout all stages of the design of Model 480 (as it is called), particular attention was paid to accessibility and ease of maintenance in the field. Involute splines are used throughout the machine, and all high-speed shafts run on heavy-duty ball or roller bearings. To suit the requirements of Canadian conditions, all materials have been carefully selected to provide high strength and shock resistance at sub-zero temperatures.

Dominion Engineering's latest dressed as a shovel . . .

. . . and here as a crane with a mighty longarm reach.

The machinery desk revolves on a high carbon steel double flanged roller path with flame-hardened surfaces. Four equalizing hook rollers are provided at the front of the machinery deck and two at the rear. The internal ring gear is machine-cut and is replaceable rather than cast integral with the roller path.

To overcome the difficulties of crawler adjustment during extreme winter conditions, a new type of built-in jacking system has been adopted. No screw threads are exposed and crawler drive and idler axle blocks are solidly locked against removable shim packs to ensure permanent alignment.

Crawler steering and travel functions are air-controlled, and to simplify operation (particularly with shovel or pullshovel equipment) digging locks can be set to allow free travel in one direction only or locking in both directions. Independent travel mechanism with two speeds, under the control of twin reversing clutches, is an additional feature.

The boom hoist is independently controlled for all machine functions except crowd shovel, and provides a high line speed when desired. Safety boom lowering equipment can be supplied as additional equipment for crane service, and an air-operated safety dog positively locks the mechanism when the boom hoist is not in use. Also for crane service, a swing brake can be supplied in addition to the standard swing lock. (233)

dc motors and generators: designing to new standards

A few years ago the National Electrical Manufacturers Association (NEMA), recognizing the modern role of dc drives, undertook the formulation of new suggested standards for dc motors and generators in the integral hp range (from 1 to 200 hp and ¾ to 170 kw).

The most significant change was the adoption of Class B ratings: 60 deg C rise in the case of open machines. This makes possible lower armature inertias and the faster response that is essential to modern dc applications.

Generator ratings were revised to match more closely standard ac drive motor outputs and dc motor power requirements in order to reduce the idle capacity of previous m-g sets when used to power single dc motors. This reflected the adjustable voltage techniques prevalent in modern dc applications.

Continued on page 80

Cyclotherm Division, National U.S. Radiator Corp., Oswego, N. Y., increases drafting room output with Kodagraph Autopositive Film intermediates. These extremely translucent "masters" also produce sharper prints for this leading manufacturer of oil- and gas-fired steam and hot water generators.

"Like having 6 times the drafting room force"

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Another big time-saver—Cyclotherm's complicated drawings must be changed constantly to meet customer requirements. No redrafting . . . drawings are reproduced on Autopositive Film. Unwanted detail is removed . . . new detail drawn in.

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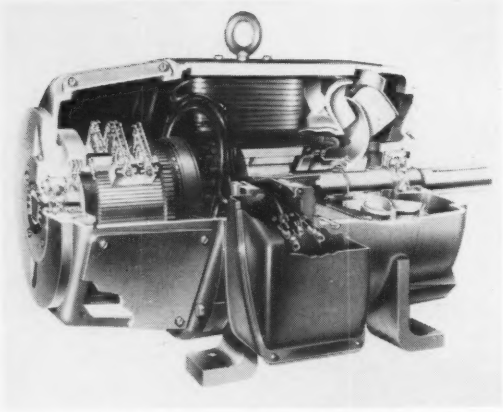


Cutaway clearly shows controlled ventilation design.

The motors and generators in the **Westinghouse** Life-Line H series, have been designed within the framework of these standards.

Since the standards are broad, they by no means tell the full story of the new line.

Careful laboratory studies of cooling requirements and the fluid mechanics of air flow in dc machines were conducted and a new ventilation system evolved. Known as "Controlled Ventilation," this system does three things: it cleans machine parts instead of contaminating them; it positively distributes air for the best cooling and it moves more air than other schemes.

In conjunction with an air shield and a specially designed diffuser, a large aluminum fan forces air into the machine from the drive end. Air flows toward the commutator end, and conducting brush dust goes directly from the commutator out of the machine rather than into the windings. Further, any external material drawn into the machine does not strike the commutator directly. The diffuser has separate ducts leading to the armature and fields. These divide the air to the best advantage; most air flows to the armature where it is needed, less to the fields. Distribution is not left to chance. Finally, it will be seen that, with flow toward the commutator end and with positive air distribution, the natural fans in the armature add to the flow instead of bucking it. Real use is made of the armature core ducts and coil ends for cooling where it can do the most good.

It is also worth noting that the controlled ventilation of the new Life-Line H is quieter than a centrifugal fan discharging directly out of the machine. By directing air flow from the fan into the windings, a muffling action is obtained. (234)

Metallic seals: searching for new solutions

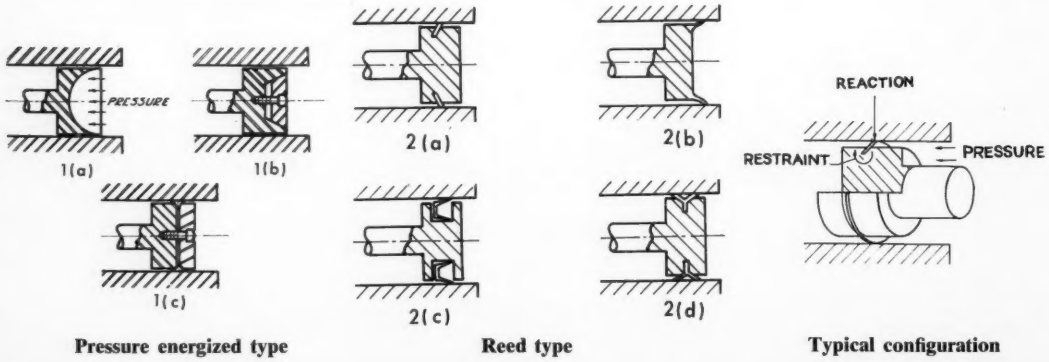
There appears to be a real need for a metallic seal which will operate satisfactorily at temperatures well in excess of 500 deg F, which will contain pressures greater than 3000 psi, be capable of enduring a large number of thermal cycles and have leakage characteristics and service life at least as good as the O-rings in today's aircraft. In response to these needs, **Autonetics** (a division of North American Aviation, Inc.) has embarked on a program of evaluating and testing metal dynamic seals in aircraft hydraulic equipment.

A number of metal seals might have potential use in aircraft hydraulic systems. Some of these are shown in Fig. 1. These seals are all of the pressure energized type. In this type, the pressure differential is used to produce a more perfect seal. In addition, seals 1 (b) and 1 (c) have means for developing an initial interference fit, so that the seals will not leak at low pressure.

Metal seals of the reed type are commercially available. These seals are truncated cones of metal, as shown in Fig. 2 (a). Seal 2 (b) is a lip seal of a type patented by J. Mercier. Seals 2 (c) and 2 (d) represent other configurations being tried by researchers in the field. These are all pressure-energized seals having an initial interference fit.

A complete analysis of any of these seals would have to consider the seal as being similar to a belleville spring. Taking the configuration of Fig. 3 to be typical of the pressure-energized portion of each of the designs, it can be seen that the spring is uniformly loaded on one side by pressure. This loading is opposed by the cantilever restraint of the piston mounting and the reaction on the cylinder wall. As any outward deflection of the cylinder wall (or any bending in the seal cone) will result in an increase in the circumferential dimensions of the seal, the analysis as a belleville type spring becomes extremely ponderous.

Further details are given in an SAE paper by Keller and Stafford. (235)



Pressure energized type **Reed type** **Typical configuration**

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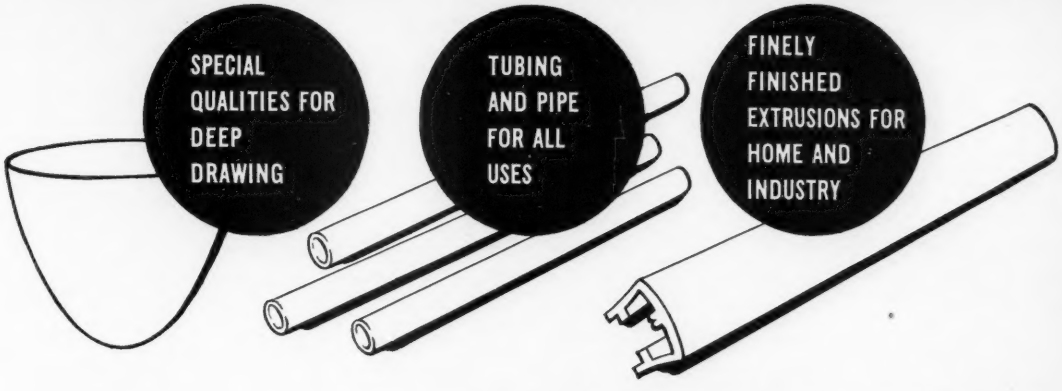

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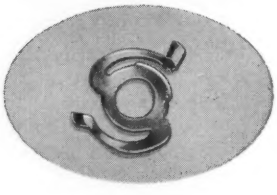

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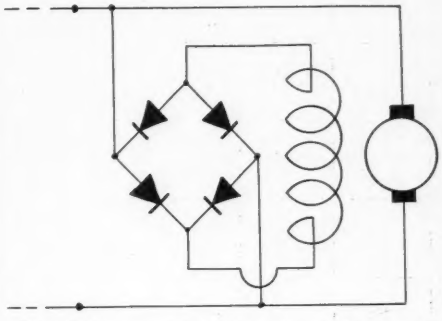
dc motor: here's a way of reversing it

It is well known among electrical engineers that reversing the leads of a dc motor has no effect on the direction of rotation of the armature (unless a fixed field is used). This is because the current is thereby reversed in both the field and the armature, so the net effect is "no change." To make such a motor reversible (by reversing the direction of the applied voltage), relays are sometimes used, but the complication is rarely worth while.

It is not generally known, however, that a dc motor can easily be made reversing by inserting a bridge rectifier in the field or armature circuit. The field is preferable, for less current is taken and a smaller unit is used. The exact size will depend on that of the motor.

The circuit attached shows how to connect the field internally to the terminals through the rectifier unit and it will be realized that reversing the motor leads (or current therein) will reverse the current to the armature but not the field and the direction of rotation of the motor shaft will be reversed. (236)

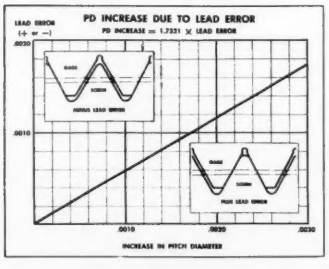


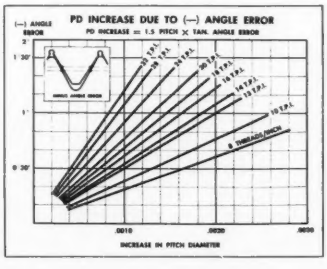
The field connected through rectifier unit:

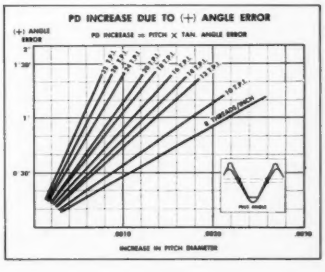
Screw threads: there's more than one sort of misfit

There's more to diameter than meets the eye, at least when it's the pitch diameter of screw threads that you're talking about. A new Standard Pressed Steel Co. booklet on thread gauging shows that variations in screw thread angle and lead produce misfit fasteners as readily as do deviations in the pure diameter dimension itself. This is because both lead error (faulty spacing of individual threads) and angle error (deviation from standard 60 deg thread form) always act to increase the "effective" diameter of a screw thread. The increase can be considerable, as shown in these charts taken from the SPS booklet.

The result of all this can be to place the fastener user on the horns of a diameter dilemma. Unless he uses two basically different types of pitch diameter gauge, one that is affected by lead and angle errors for use as his Go gauge, and one that measures only the pure diameter dimensions for use as his Not Go gauge, he may accept misfit fasteners. (237)







Hydraulic coupling: hp boost from an auto fan

A thermostatically controlled hydraulic coupling on the engine fan is effecting a power boost of up to 17 hp on the 1957 Mercury automobile. It does so simply by basing the speed of the fan on engine coolant temperature rather than on engine speed.

Identified as a Thermo-Modulated drive by its manufacturer (the Schwitzer Corporation), the coupling is made up of two mating faces, separated by Dow Corning Silicone 200 fluid. At coolant temperatures below 160 F, the distance between faces (plus the viscosity of the fluid) combine to keep the fan speed down to less than a quiet 1,500 rpm.

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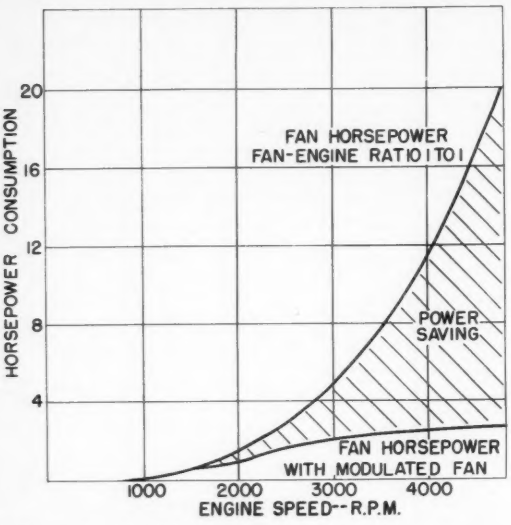
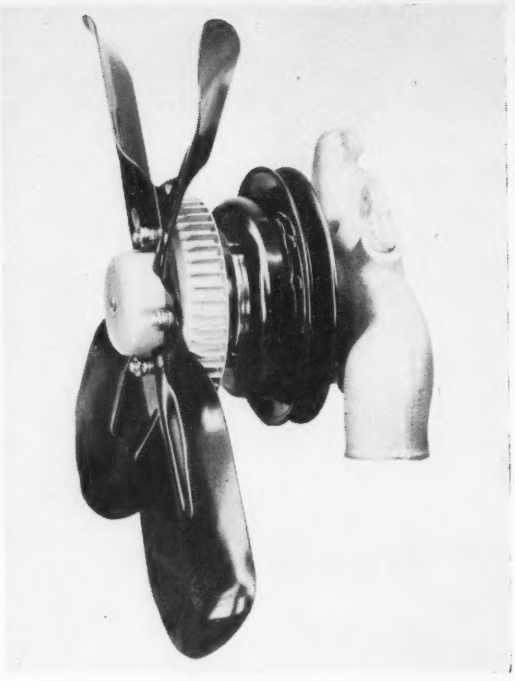




Above: Graph of hp consumption/engine speed in rpm. Right: Cooling fins to dissipate the heat generated.

Should engine temperature approach the 190-200 F range, however, thermostatic control brings the coupling faces closer, the fluid achieves better traction and the fan picks up speed. But even than at about 1,250 rpm the fluid begins to shear, until at 2,600 rpm (or so), fan speed becomes constant.

As a result, fan horsepower requirements are held to a minimum and fan noise almost entirely eliminated.

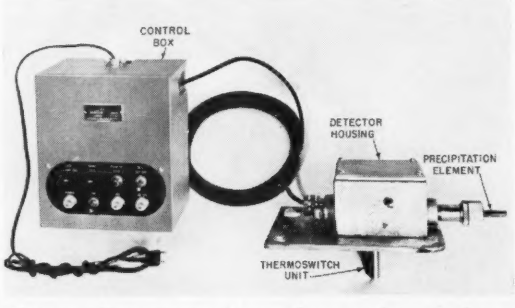
Schwitzer has also developed a straight modulated drive coupling without the thermostatic control feature. This unit is being used by several automobile manufacturers in connection with their air-conditioned models, in which the cooling and power requirements of the engine and the air conditioner may be effectively balanced against each other.

Reliability of all these couplings is assured by the use of silicone fluid as a driving member. Conventional organic oils would thin out with increased temperature and become too visccous in cold weather, completely changing the characteristics of the coupling from those required. Silicone fluid also eliminates maintenance problems. In tests, the fluid shows no sign of gumming, sludging or varnish after as many as 1,000 hr of steady operation, the equivalent of 100,000 miles. (238)

Alarm system: de-icing the antenna towers

A new type of sleet-and-ice alarm system, designed to detect incipient icing conditions, has been developed by the American Instrument Co., Inc. for protecting antenna towers. Approximately 100 of these systems have been furnished for protecting radar towers on the DEW line and Project Alice. Icing is a problem on antenna towers, not only because it deposits a heavy and sometimes hazardous weight on the structure, but also because it distorts the beam pattern and increases power leakage. Besides radar tower applications, the system can be used to detect incipient icing conditions around airports, buildings, highways and other locations where advance warning of icing would provide valuable operational guidance.

This particular system differs from existing ice alarm systems (such as the venturi-type or strain-gage type) in that it responds when atmospheric conditions favor ice formation, before the ice actually forms. Because it gives early warning, the system enables the necessary precautions to be taken before conditions become



The ice alarm system is complete as pictured above.

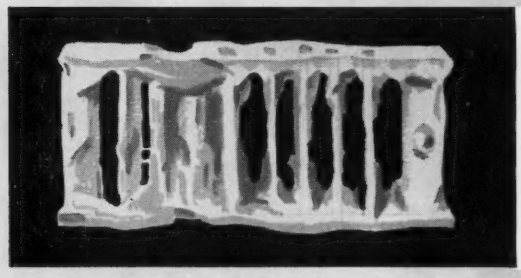
troublesome. Apart from the time factor, another advantage of an advance ice warning is that power consumption by antenna heaters is reduced, since the heaters seldom have already-deposited ice to cope with. In

Continued on page 86

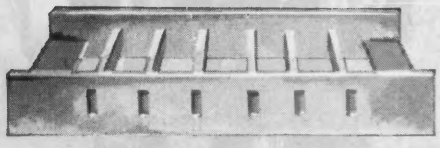
INCO CUSTOMER SERVICE AT WORK

High Temperature Service

Test racks are used by Inco engineers to determine the effects of high temperatures on alloys. Below is a test rack after exposure to heat conditions in industry. From a study of this, Inco engineers are able to recommend the best alloys for specific operating conditions. If you have high temperature problems, this service will prove useful to you.



another example of the way Inco Research helps solve your metal problems



Inco has tested many metals and alloys for high temperature performance over a long period of years. Already a vast fund of such information has been accumulated. Through Inco Customer Service, this is available to you.

A High Temperature Work Sheet, *copies of which are available to you on request*, has been prepared to make it simple for you to outline your high temperature problems. With it, Inco engineers can give your problem careful consideration. If the data already on file are not sufficient to provide a solution, further tests will be conducted. Engineers are available for consultation and on-the-job assistance.

Inco Customer Service stands ready to help you solve other metal problems. We invite you to call on us for information involving welding and fabrication, foundry practice, metals selection, high and low temperature service, mechanical and physical properties and performance characteristics. That's why we say:

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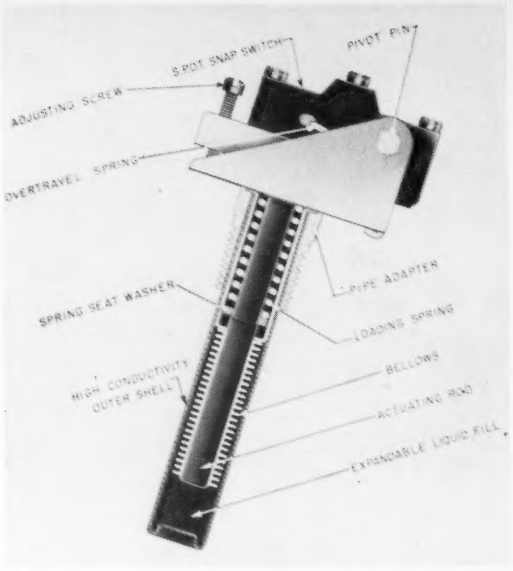
remote northern areas, the reduction of antenna heat requirements constitutes an important economy, because all supplies (including the fuel to operate power generators) must be flown in during the few months of relatively good flying weather.

The system (Fig. 1) consists of two parts: the detection unit, installed on the antenna or other outdoor location; and the control box and associated alarm devices, installed indoors. The device can anticipate icing because it is actuated by two types of sensing element which respond to the two ice-forming conditions, that is, low temperatures and precipitation. The two sensing elements are connected in series so that the alarm system will remain inoperative unless both conditions exist concurrently. When the alarm circuit actuates, a SPDT relay switches off the "no ice" indicator light on the control box, energizes the "ice" indicator light and sounds an alarm bell. The alarm circuit will also turn on the antenna heaters, if desired. As soon as the icing conditions pass, the system clears itself automatically.

The two sensing elements in the detection unit consist of a specially-developed element to monitor precipitation and a Fenwal snap-action Thermoswitch unit (Figure 2) to sense air temperature. (239)



Cut-away of Fenwal's snap-action Thermoswitch unit. This is the temperature-sensing part of the detector.

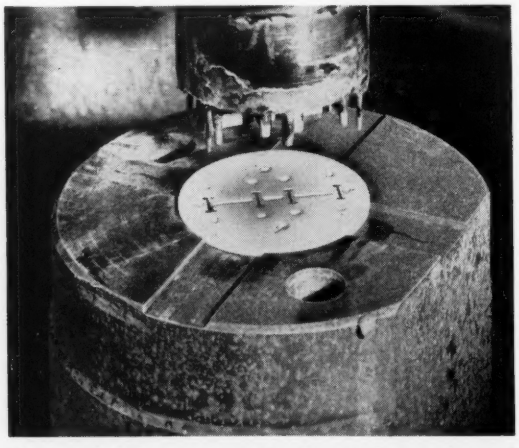
Drilling: abrasive particles in a hurry

A technique for the ultrasonic drilling of ceramic tube spacers has just been developed by C-Mar Corporation. This new process offers electronic manufacturers broader freedom of design by making possible, for the first time, volume production of close-tolerance ceramic parts with intricate configurations.

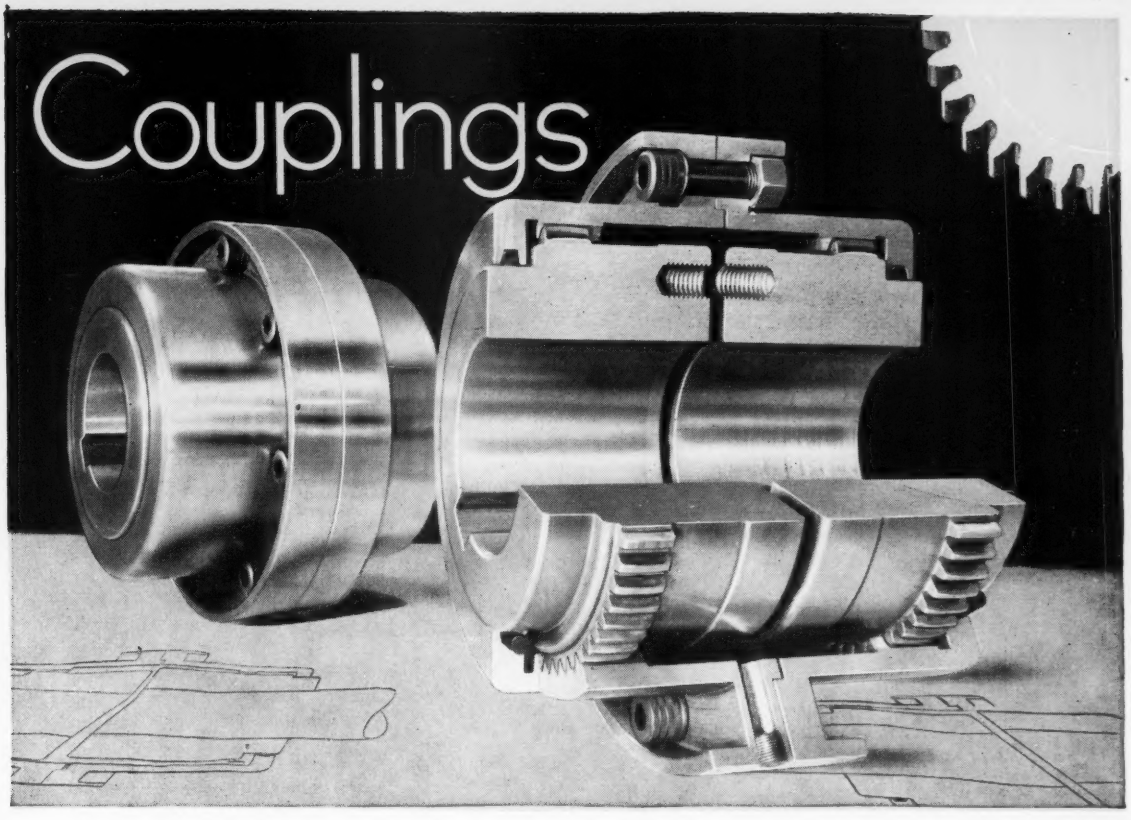
The process employs an electro-mechanical transducer that converts alternating current into mechanical force to vibrate the impact tool at 25,000 cycles per second. Particles of abrasive, introduced as a slurry between work and tool face, are driven with tremendous impact to reproduce an exact counterpart of the tool face in the workpiece. As a result, intricate orifices, multiple arrangements of holes and slots, and other complex configurations are cut into the workpiece in a single operation. Because the work is not chipped, spun, stressed or distorted, parts can be shaped to close tolerances with high piece-to-piece reproducibility.

A typical example of dramatic product design improvement resulting from the process is the case of a leading manufacturer of ruggedized tubes. Through the use of alundum (aluminum oxide) spacers developed and machined by C-Mar, the company has reduced tube noise and tripled the life of its tubes. (240)

Life of this ruggedized tube is tripled by replacing conventional mica spacers with ceramic spacer discs.



Slots and holes are cut simultaneously as the tool drives abrasives into the ceramic spacer at 25 kc.



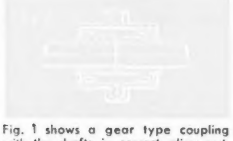


Fig. 1 shows a gear type coupling with the shafts in correct alignment.

Fig. 2 shows the displacement of the coupling where shafts are parallel but out of line.

Fig. 3 shows the gear type flexible coupling where the shafts are angularly out of line.

Fig. 4 shows the gear type flexible coupling coping with a combination of errors of alignment both angular and offset.

Hamilgear Flexible Couplings

HAMILGEAR flexible couplings are of modern compact design combining all the desirable features necessary to insure long trouble free operation and maximum load carrying capacity for all possible conditions of misalignment shown at the left.

Tooth flanks of the external teeth on the hubs are crowned to give a "barrel" shape. The amount of curvature is proportioned to balance the requirements of eliminating edge tooth contact when connecting misaligned shafts, and still assure maximum load carrying capacity with minimum tooth stress.

The internal gear sections are widely spaced to keep the angularity resulting from offset misalignment at a minimum.

Shear stress on the flange bolts is taken on the full bolt diameter rather than on the threaded portion.

Lubricant is retained in the coupling and dust and dirt excluded by oil resistant synthetic rubber "O" rings.

HAMILGEAR flexible couplings are available in stock sizes and types and special designs where required.

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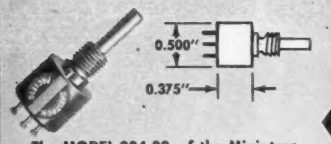

The MODEL 304-00, of the Miniature Single Turns group.

MINIATURE SINGLE TURNS—Only 0.375 inch body length by 0.500 inch diameter, 10 to 50K ohms, wire wound; linearity from 3 to 0.3%; 2 watts at 50°C, 0 watts at 125°C.

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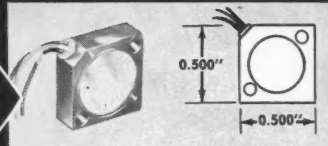
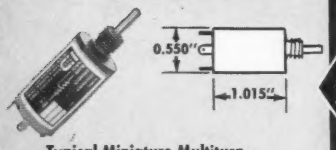


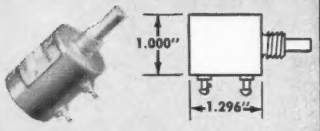
MODEL 300-00, one of the many Trimming Potentiometers



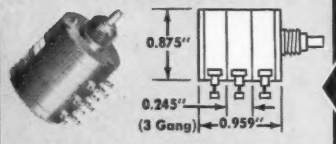
Typical Miniature Multiturn—the MODEL 341-60

MINIATURE MULTITURNS—The smallest precision, ballbearing, 10-turn pots offer maximum reliability with unique zero backlash construction and double wipers; 20 G's to 2000 cyc; to 250K ohms; 2.5 watts at 40°C, 0 watts at 140°C; panel or servo mount.

GENERAL PURPOSE MULTITURNS—To 500K ohms, wirewound, to 4 watts at 40°C, 0 at 100°C; as small as 1.0 inch diameter, sleeve or ball bearing, excellent resolution, designed to fit ALL applications.



MODEL 400, typical of the General Purpose Multiturns



Representative of the Ganged Single Turns—the MODEL 319-60

GANGED SINGLE TURNS—Unique screwdriver phasing, no clamp rings or movable cups; minimum depth "per cup"; from 0.875 to 3.0 inch diameter; to 500K ohms, wire wound with exceptional linearity and resolution.

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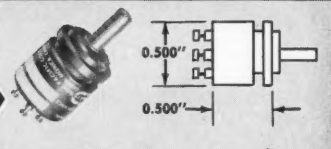

Typical of High Temperature Designs—MODEL 314

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Quotes

Motocylinders

A new tool for machine designers was dealt with in an article by P. A. Rabideau in the **Westinghouse Engineer,** July 1957, p. 126.

A motocylinder can be used on most machines where reciprocating motion is required. Suitably applied, it can perform functions that are now being carried out by pneumatic and hydraulic cylinders. For example, in the automotive industry, motocylinders can be used on shuttle-transfer mechanisms, welding presses and numerous transfer and indexing devices.

A motocylinder is an electric-motor driven, geared thrustor. This simple electromechanical device consists of an electric motor driving the high-speed shaft of the gear unit; a crank arm on the slow-speed output shaft of the gear unit imparts reciprocating motion to the driven machine. Limit switches operated by the crank arm provide the necessary intelligence for stopping and starting the motocylinder at a desired position. If mechanical braking is desired, a disc-type brake is flange mounted to the motor.

Engineering bulletins

University of Illinois engineering experimental station bulletins deal with: Static strength of rivets subjected to combined tension and shear (William H. Munse and Hugh L. Cox); Torsional properties of steels at high rates of strain (Paul G. Jones and Thomas J. Dolan).

Controller

The latest contribution of the Taylor Instrument Company to the field of miniature instrumentation is their Transcope controller, described by R. I. Edelman in the Spring 1957 issue of **Technology.**

The new controller is a non-indicating, motion balance, plug-in type instrument, designed for those applications where it is necessary to transmit the measured variable pneumatically to an indicator or recorder. When a controller of this type is used, separate provision must be made for pneumatically adjusting the set point, and for placing the process on manual control.

The instrument may be located either at the point of measurement, at the set point adjusting station or at any convenient intermediate point depending upon installation.

Both the process variable (transmitted pressure) and the set point are introduced into the controller pneumatically.

Silver plating

A technical paper has been prepared by **Sel-Rex Corporation** describing their new Silvrex bright silver plating process.

Covered in detail are such vital topics as bath make-up and maintenance; anodes, tanks and temperature: current densities; agitation; plating procedure, and simplified removal of solution impurities.

Introduced to the trade recently, the process is claimed to give a mirror-bright finish directly from the bath through a complete range from flash to extra heavy deposits. It also produces hard (Brinell 135) and highly ductile deposits.

Fatigue

In an article by John C. Levy in the **Journal of the Royal Aeronautical Society** (July 1957) there is an article: "Cumulative Damage in Fatigue—A Design Method Based on the S-N Curve." It is suggested that a convenient way of presenting the results of fatigue tests (in which two different stress amplitudes are supplied alternately) is to plot log N against log (n_1/n), where N is the total cycles to failure and (n_1/n) is the fraction of cycles run at the high stress. With these co-ordinates, a simple geometrical construction gives a safe design method for the two-stress level system using only the conventional S-N curve and the value of (n_1/n) expected to be encountered in service. If N_1 and N_2 are the lives at the high and low stresses (as read from the S-N curve), one point may be plotted at (log N_1,0) since this represents the program when all cycles are at the high stress. On the assumption (shown to be justified) that less than one cycle of high stress per 10,000 total cycles would not significantly affect the life at the low stress, a second point is plotted at (log N_2, $\overline{4}$). The straight line joining these two points is always found to predict safe values of N for any value of (n_1/n). This conclusion is checked against a wide range of experimental results taken from six different sources in the literature covering rotating-bending and push-pull tests (ferrous and non-ferrous metals) any order of stressing and length of program cycle from 50 up to 5 million. This last feature means that the length of the program cycle in service need not be known. All that is required is the proportion in which the two stress amplitudes are mixed. The average value of the ratio (experimental life/predicted life) for the data examined is 1·8, the extreme values being 1 and 5·6. By plotting in three dimensions, an equation is also developed for the three-stress level spectrum and a suggestion is made for an extension of the method to multiple stress levels.

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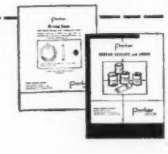

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Temperature control

(Continued from page 75)

around the heat source will introduce a series of rapid pulses of heat into the system, approximating in effect a constant heat input. As long as the heat loss of the system remains constant, temperature fluctuations at the load will be kept to a small value.

In a dynamic system, placing the thermostat near the heater is not generally the best solution. With this orientation, although the thermostat can respond quickly to temperature changes at the heater, it cannot, due to its great distance from the load, respond quickly to changes in heat demand at the useful working area.

Generally, in most practical systems, the most satisfactory arrangement is to compromise somewhat between the two extremes, so that the control element is in a position where it can respond quickly to temperature changes either at the load or at the heater. The closest temperature control will be obtained if the thermostat can be sandwiched between the heater and the useful working area (Fig. 4F).

Although, for simplification, this discussion has dealt with systems having a single source of heat, the same principles apply when the heat source is made up of a large number of scattered small heaters. Temperature gradients will exist, but they will be smaller. Locating the thermal element adjacent to any one heater will increase the cycling rate. An ideal solution is to distribute the heating elements throughout the useful working area and locate the thermostat in such a position that it can sense representative temperatures of both the heaters and the section to be controlled.

Heat balance, a measure of heater capacity with respect to the heat requirements of a given system, will have a direct effect on the temperature control attained. In an evenly balanced system, the heater will be energized 50% of the total time. As a general rule if the heater is on more than 60% of the time under normal operating conditions, its rating should be increased. If it is on less than 40% of the time, its rating should be decreased.

The set of three temperature control curves in Fig. 5 demonstrate the importance of correct heat balance in a thermal system. The curve at the left illustrates the unsatisfactory control resulting when the heater is several times the required size.

The centre curve demonstrates the control that will be obtained in a balanced thermal system (50% heat-on time). Note that the rates of heating and cooling are approximately equal and that the total temperature deviations

from the centre of the control band are small. The control is good. This system is sufficiently flexible to maintain good control even if the heat demand should increase (or diminish) by fairly substantial amounts.

The curve at the right illustrates the control obtained when the size of the heater barely exceeds the basic requirements of the system. Note that even though the heater is on almost continuously, the system will rarely be at its controlled temperature.

When installing heaters in a system, it is important that the transfer of heat from the heater to the heat transfer medium be as effective as possible. If the transfer medium is metallic, the best heat transfer can usually be obtained by having the heater cast integrally within the block itself. If this is not possible, the heater should be attached securely to the block and be in intimate contact over as large an area as possible. It is essential for all dead-air spaces between the heater and the block to be reduced to a minimum. Large thermal lags will otherwise be introduced. Such air gaps can insulate the heater from the rest of the system and cause the heater temperature to be excessive. This can greatly reduce the life of the heating element.

With radiant-type heaters it is very important to make certain that the radiant energy is directed toward the working area by suitable reflectors and that the heaters themselves are so placed as to ensure a uniform distribution of heat.

Regardless of the type of heater selected, it is usually desirable to incorporate the largest practical number of heaters to make up the total desired heat input. The principal advantage of multiple heaters is the better (and more uniform) heat distribution throughout the process, with the consequent reduction of extreme thermal gradients among the various portions of the system. The thermal gradient can be further reduced by concentrating more heat where the heat losses will be greatest (such as near the edges of a molding press) in order to maintain a more uniform temperature throughout the working area. Using several individual heaters also reduces the replacement cost in the event that one burns out.

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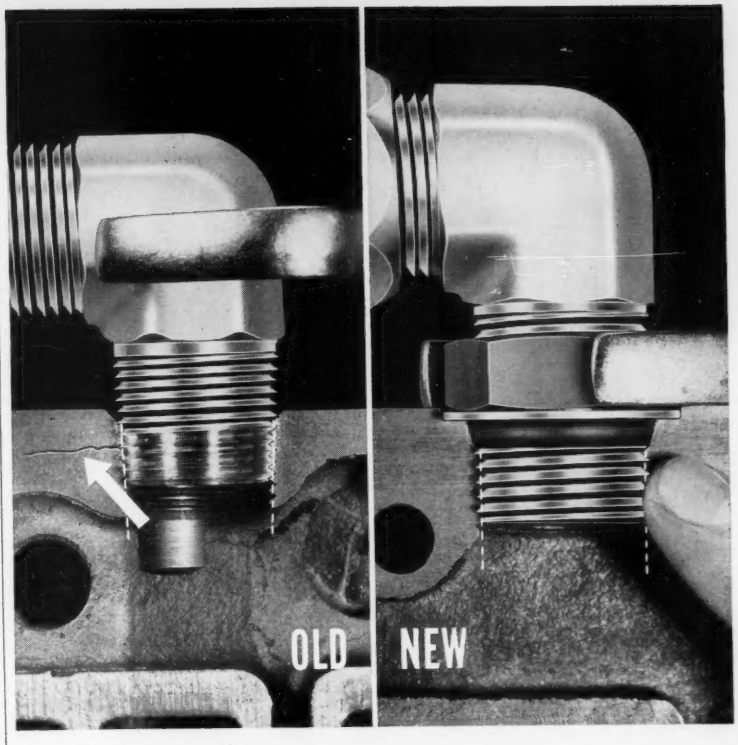

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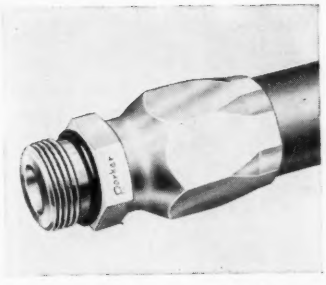

New, Broader Line of *Hoze-lok* fittings for medium- and high-pressure hydraulic service. No skiving of hose cover. Easier make-up saves time and money. Longer performance, greater re-usability. Catalogs 4433 and 4434.

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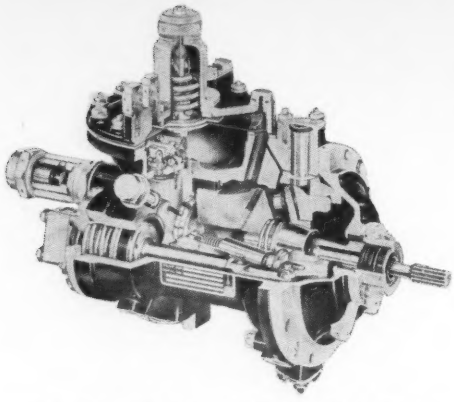

The new C-size fuel pump for gas-turbine engines

Hydraulic offspring of fuel injection

A company's fuel injection pump initiates a line of hydraulic pumps

A range of hydraulic pumps and motors has been developed from the well-known Lucas fuel injection pumps, used so extensively on aircraft gas turbine engines since 1940. These units provide a range of pumps and motors, capable of high duty, compact in size and low in weight to meet modern needs.

The pumping element consists of a rotor supported in bearings. The seven cylinders (there are five or three in the smaller units) may be inclined or parallel in the rotor and accommodate hardened steel pistons. The ends of these project from their respective bores and are ball-shaped to take socketed slipper heads which engage with an appropriately shaped camplate. This is mounted in a control ring, the angle of inclination of which can be varied from zero to maximum stroke.

A slipper retaining plate is drilled to take the slipper shanks. It supports the slippers in position against the camplate face. At its centre it runs on a hemispherical bush, spring loaded to give slight fore-and-aft play, thus avoiding any possibility of seizure or chatter.

From the underside of each piston, a centre hole is drilled (through the ball-shaped end) to provide a film of oil for the underside of the slipper. A central hole in the slipper face admits this graduated leakage to the bearing surfaces of the slipper and the camplate for the same purpose.

The piston bores in the rotor are stepped in diameter, the smaller inner ends terminating as ports in the flat face of the rotor, which rotates against an insert in which are cut kidney-shaped inlet and delivery ports. A pressure-tight seal results from the rotor being pressed against the insert by the fluid pressure acting on the annulus formed by the stepped portion in the piston bores, together with the thrust ball spring. This design gives a sealing force proportional to the fluid pressure.

A stall valve safeguards the unit against overloading, while the pump output can be varied either directly or by a remote control.

Performance figures for these units as pumps and motors are given in the table that appears below. ★

Type	Fluid Displacement (gph /1000 rpm)	Nominal working pressure	Nominal Speed		Approx. weight (lb)	hp Generated /1000 fpm/1000 psi differential	Max. torque per 1000 psi fluid pressure differential (lb-ft)
			Pumps	Motors			
IP 36	36	1000	4000	....	6.0	....	....
IP 60	60	3000	5000	6000	7.0	0.56	3.3
IP 125	125	3000	3000	6000	7.6	1.18	7.0
IP 525	525	3000	3000	4000	24.0	4.94	29.26
IP 1000	1000	3000	3000	3000	32.5	9.35	55.00
IP 3000	3000	3000	2000	2000	120.0	28.00	166.00

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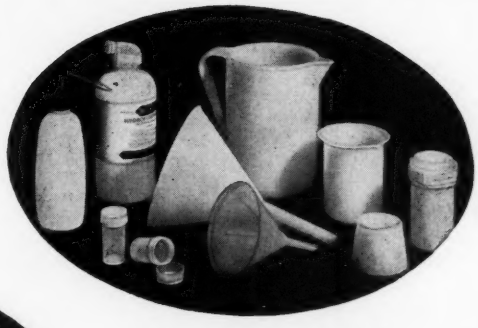

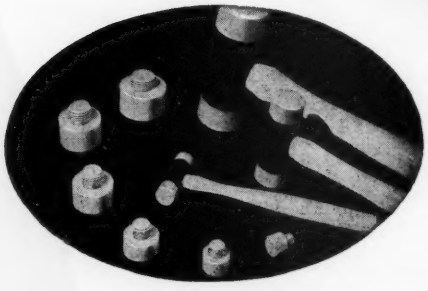

workshop

practice these days calls for replaceable hammer heads such as those of polythene; tough enough to drive close tolerance parts, yet resilient enough not to mark or distort them.

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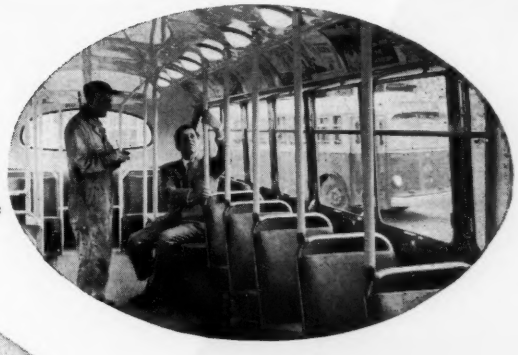
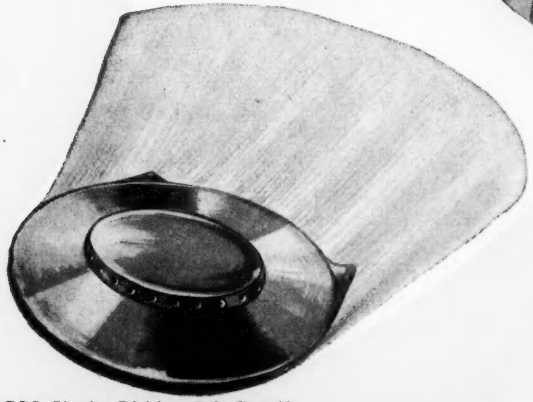
polythene covering the hand rails in this bus provides a better grip, protects the rail from saline corrosion, cleans easily, is pleasant to the touch.





designers!

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Non-circular gears

(Continued from page 66)

velocity ratio or displacement.

For a particular velocity ratio function the gears can be modified but the members will not be identical and α will not be constant. They can be used in calculating instruments, uniform scale gears and the like.

Generation. In the layout of non-circular gears it is generally better to treat the pitch lines as a series of circular arcs (as discussed in Design Engineering, October 1956). In the case of elliptical gears, 4 arcs are satisfactory for the example given but 8 arcs may be used for greater eccentricities. In other cases, isosceles triangles can be fitted together with base angles on the pitch line and arcs drawn thereto with the vertices or centres.

Although theoretically each tooth flank should be generated on a base circle corresponding to its own radius, in practice it is more satisfactory if base circles corresponding in turn to each are used. Eccentric gears can be cut as for circular gears. For other continuous gears a DP and pitch can be chosen as for a circular gear of approximately equal size, the number of teeth deduced for the actual periphery and adjusted to an integral number. Then the pitch can be recalculated.

Conclusion. It must be realized that the above calculations have been simplified as much as possible without omitting essentials. Constants have been avoided from formulas (where practicable) and constants of integration omitted when equal to zero. This has been to enable a quick understanding of the principles to be grasped. Formulas for the three cases have been worked out but this should not preclude working out results from first principles.

It will be understood that designing gears to a particular displacement function gives the quickest theoretical result and the realization that gears might be treated in reverse led the writer to investigate this angle. On the other hand, practical considerations might take precedence. For example, in designing a steering gear, the mechanical advantage should theoretically be calculated for a series of positions, the velocity ratio deduced assuming an efficiency curve and and then the gear form calculated as described. In practice, however, it is preferable to select an eccentric gear of appropriate size and design the rack to suit.

It is therefore hoped that the results will enable designers to use these gears when otherwise, through lack of understanding of the fundamentals, they would have been avoided. ★

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New products & materials

Lined steel pipe

Noncontamination and nonadhesion are two of the qualities that make Teflon lined steel pipe **(Haveg Industries, Inc.)** valuable in many industries. Its fields of use include food processing, pharmaceuticals, textile, chemical processing, metal finishing, beverage and bottling, oil and petroleum refining and mining.

Because Teflon is impervious to the attack of nearly all acids, chemicals, solvents and caustics, it has no toxic effects and will not contaminate those products it carries. It will solve the toughest corrosion problems. Heat resistant as well as chemically inert, pipe lined with it has the added strength and safety factor of the steel casing, allowing it to take the roughest kind of abuse. It will withstand temperatures up to 400 F, with pressures of 300 psi. (214)

Rectifier stack

Compact 23 kw silicon single phase bridge rectifiers (engineered for heavy power conversion in high ambient temperatures) are now in full production at **International Rectifier Corporation**.

Designed for forced air or natural convection cooling, these units consist of four of their silicon junctions mounted on an efficient heat exchanger for optimum cooling.

The single phase bridge rectifier stack is rated at 50 amp, rectified dc when convection cooled, and 120 amp rectified dc when forced air cooled at 1,000 lfm. Maximum input voltage per junction is 210 v RMS. (215)

Exhauster

A new exhauster known as the Tornado Weldafume unit **(Vokes Canada Ltd.)** removes the heat, fumes and dust of welding operations from the vicinity of the operator, thereby contributing materially to his efficiency and the improvement of local conditions generally.

A flexible metallic hose enables the unit to be placed in the position most convenient for the welder and for the type of work being carried out, and also facilitates the removal of fumes or smoke from out-of-the-way and otherwise inaccessible positions. The unit is particularly valuable, therefore, where welding operations have to be carried out inside large drums or boilers.

The special asbestos base, fire-proof cloth filter (incorporated in the unit to arrest light slag and flux dust) contains over 1,000 sq in. of filtering surface, thus ensuring a very low air velocity and high efficiency.

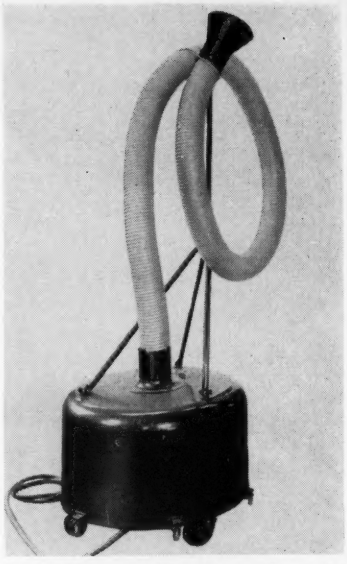
Where arc welding or bronze welding is in process on galvanized or similar work, the set is especially desirable for removing the more irritating fumes produced by these processes from the breathing zone of the operator. (216)

Cable clips

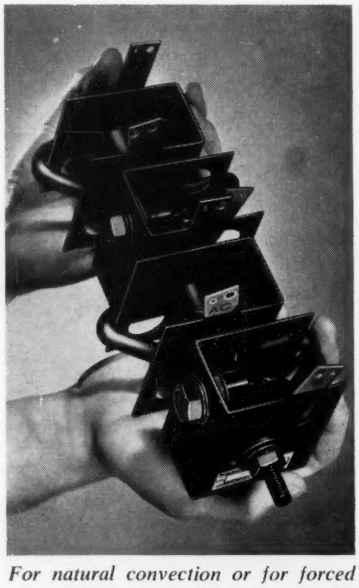
New instant snap clips developed by the **Weckesser Company,** make fast work of cable and tube anchoring operations. The installer simply pinches the ends of the black nylon clip together, inserts it in a mounting hole and lets go.

All the advantages of nylon are incorporated in the one-piece clips. They have excellent insulating properties, toughness over a wide-range of temperature, resistance to corrosion and they are non-magnetic.

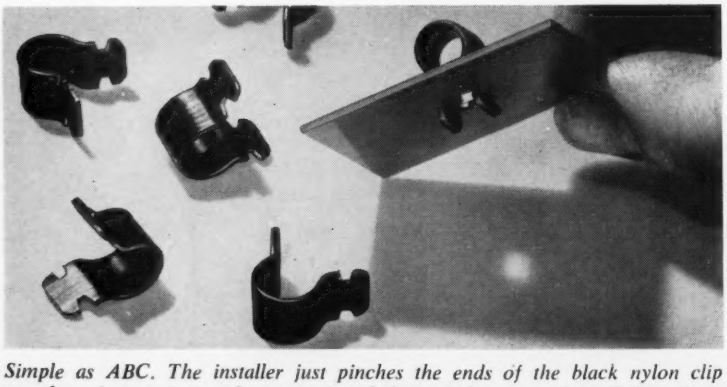
These clips completely eliminate the need for screws, fasteners and other small parts that make cable mounting tedious and time-consuming. They reduce the number of parts needed for the operation and provide a lowcost, quick assembly. (217)



A flexible metallic hose allows its exact positioning. (See 'Exhauster')



For natural convection or for forced air cooling. (See 'Rectifier stack')



Simple as ABC. The installer just pinches the ends of the black nylon clip together, inserts it in the mounting hole and lets go. (See 'Cable clips')

The flanged Teflon lining forms its own gasket. (See 'Lined steel pipe')

Continued on page 100

Book Department

Engineering Properties and Applications of Plastics by Gilbert Ford Kinney (Wiley). This book is written for those who work with plastics or who require background information for the proper use or specification of these materials. The various plastics are described separately, more or less in the order of increasing complexity. A unified treatment (rather than a topical approach) permits the principles, concepts and terminology to be established in the simpler cases, and used in treating the more complex materials.

Separate chapters describe methods of fabrication, as well as the mechanical, electrical, optical and thermal properties. Also provided is an abbreviated survey of the type reactions of organic chemistry.

Emphasis is placed on an understanding of the fundamental nature of plastics. A tremendous amount of subject matter is organized in a simpler manner by selecting pertinent material to illustrate principles.

The book costs $6.75.

• • •

Practical Geometry and Engineering Graphic (6th edition) by W. Abbott (Blackie and the Ryerson Press). A course in practical geometry for engineering students who have already received some instruction in elementary plane geometry, graph plotting, and the use of vectors. Additional material in this sixth edition includes a section at the end of 20 worked examples. Cost of the book is $4.75.

• • •

Manufacturing Processes (4th edition) by Myron L. Begeman (Wiley). Every chapter has been rewritten for this, the fourth edition. Less descriptive than previous editions, the book places greater stress on principles and materials. Advantages and disadvantages of the various processes are examined in lucid fashion.

New topics discussed include electroforming, metal coating processes, electrospark machining, ultrasonic machining, chem-milling and automation. There are 166 new illustrations, 89 of which are line diagrams. The author makes valuable use of the line diagram in his presentation: there are in fact, 225 such diagrams in all. In addition, the photographic illustrations have been revised to show modern equipment. It costs $8.00.

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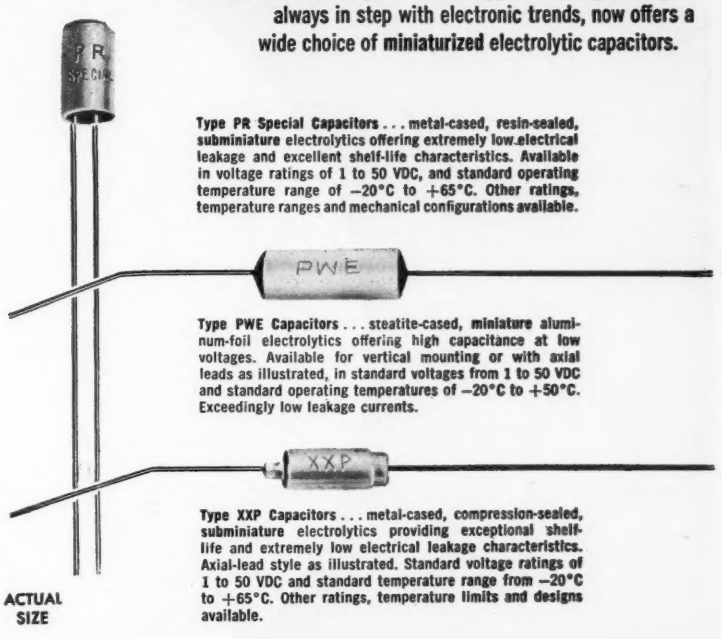

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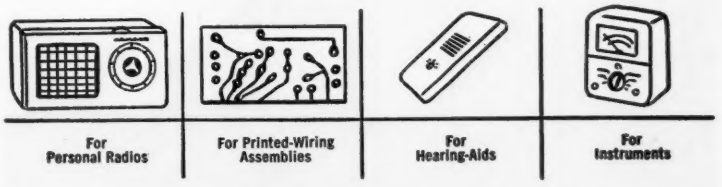
Type XXP Capacitors . . . metal-cased, compression-sealed, subminiature electrolytics providing exceptional shelf-life and extremely low electrical leakage characteristics. Axial-lead style as illustrated. Standard voltage ratings of 1 to 50 VDC and standard temperature range from −20°C to +65°C. Other ratings, temperature limits and designs available.



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- ♦ **POSITIVE, SELF-CLEANING ACTION...** no "down time"
- ♦ **SMALL SIZE plus HIGH FLOW RATES...** 12" unit shown here handles over 50 gpm
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All-metal construction, carbon or stainless steel.
Two-stage filtration. Lowest cost-per-gallon.

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New products
continued

Recording film

A new oscillographic recording film (for oil-well logging, aircraft and automotive testing and for seismic exploration) is now available on the durable and dimensionally stable Cronar polyester photographic film base, **Du Pont of Canada** has announced.

Oscillographic recording films and papers are used by engineers to determine such data as time, temperature, stress, strain, vibration and distance by means of an activated beam of light-recording electrical impulses upon a photographic emulsion.

The new material (Lino-Flex 1) produces sharp traces if good density upon a clear background. It has moderately high speed, medium contrast and is blue-sensitive. Nonhalation protection is provided by a special dye backing which disappears during processing. (218)

Industrial tractor

The four-wheel drive Ransomes Industrial tractor has been introduced to Canada by the **United Steel Corporation Limited.**

The four-wheel drive gives adequate wheel traction at all times, even under the most difficult conditions. According to the manufacturer, no machine could be simpler to drive, and steering is as easy as a modern automobile. Manoeuvrability in difficult and restricted areas is one of the features.

Among the optional equipment available is a power take-off shaft that opens a wide field of further uses; rubber blocks recommended for use on hard roads; swamp blocks for use in boggy or swampy land; front steadying wheels to prevent the front of the tractor from digging-in when negotiating steep downhill slopes; and parking brakes for use on hills and steep slopes. (219)

Solderless connection

A glass-to-metal seal with terminals or leads designed to match standard solderless type connectors is offered by **L. L. Constantin & Co.**

The special tapered pin or tab can be designed to mate with female lugs or connectors where solderless connections are required. Connections can be made quickly and easily. No soldering is required. Leads will not deform or pull loose.

The seal is adaptable for relay manufacturers or those involved in harness work or work requiring quick, solderless multiple connections. (220)

Adhesives

Ray-BOND adhesives, protective coatings and sealers are described in a four-page folder (Bulletin No. 650A) published by **Raybestos-Manhattan, Inc.**

The recommended use, method of application and properties of eight typical adhesives, representative of basic types of adhesives, coatings and sealers made by this company, are summarized and presented in concise, tabular form. The materials are: R-476 (thermosetting with phenolic resin base); R-114 (thermosetting with synthetic rubber—phenolic resin base); R-706 (thermosetting with phenolic resin base); R-4014 (base primer with phenolic resin base); R-4021 (thermoplastic with neoprene base); R-4029 (modified phenolic resin base); R-3654-X-10 (thermoplastic with synthetic resin base); and R-4024 (synthetic resin base requiring an activator for cure).

A graph shows the shear strength of five thermosetting adhesives in the temperature range from 100 to 650 F. (221)

Epoxy

A solventless, single component epoxy resin compound, having exceptionally high heat distortion, has been introduced by **The Sterling Varnish Company.**

Their U-300 Thermopoxy compound was developed for use on rotating field coils and other coils requiring a high degree of turn-to-turn bonding strength at elevated temperatures. It is also supplied in a consistency for dip application of electric apparatus, where fairly heavy films are desired.

It is a single-component system that does not require a catalyst, with a heat distortion of 150 C, far above that of other plastic insulating materials. Thixotropic properties ensure that it will not flow during the recommended curing operation. (222)

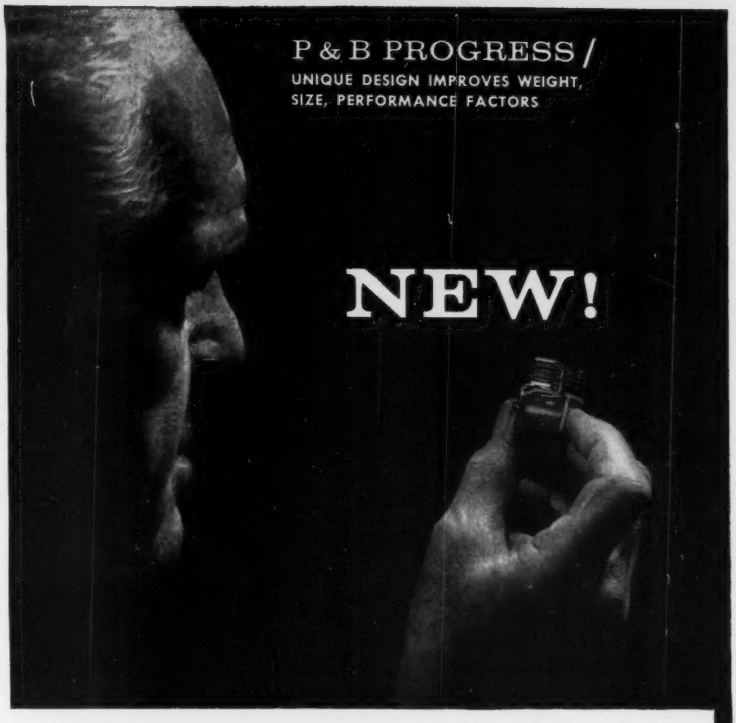
Silicone resin

A silicone resin developed by **Dow Corning Corporation** promises to establish new performance standards for high-temperature protective and decorative coatings. Identified as 808 Resin, it provides much greater gloss retention after long exposure to high temperatures than was previously possible.

Cured films based on the resin are nonyellowing and exhibit excellent adhesion, flexibility and resistance to moisture and many common chemicals. Pigment wetting characteristics are superior to those of comparable silicone resins. Blending, application and curing methods are substantially unchanged.

Developed primarily for use in formulating white and light-colored space-heater and appliance finishes, 808 is currently available in commercial quantities priced in the same range as standard silicone paint resins. (223)

Continued on page 103

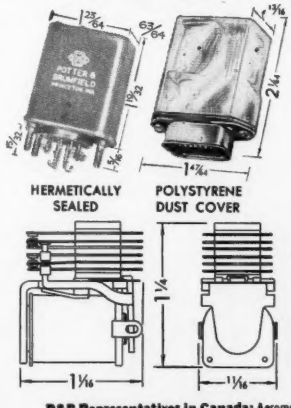


MINIATURE TELEPHONE TYPE RELAY HAS SUPERIOR SHOCK/VIBRATION RESISTANCE

Unusual for a telephone type relay, the MG Series has excellent stability under high shock and vibration conditions. Tests show this miniature, light weight (only 1.2 oz., open) relay withstands vibration of 10g 55 to 500 cycles per second and will operate under shock to 30g according to Mil-R-5757C.

The superior performance of the MG is due in part to its unique single stack construction and to an exclusive hinge design which provides zero heel gap.

Open, dust covered or hermetically sealed, the MG is available with contact arrangements up to 4 Form C (4PDT). It is rated for ambient temperatures of −55°C to +85°C. A high-temperature version with a range of −65°C to +125°C will soon be available. Write or wire today for complete specifications and delivery information.



MG RELAY

TERMINALS:
Open Relay: Pierced Solder Lugs.
Contacts: Two #18 AWG wires. Coil: Two #20 AWG wires.
Hermetically Sealed:
Miniature plug-in header with 7, 9 or 14 pins. Multiple Solder header with hook and terminals for three #20 AWG wires.
Polystyrene Dust Cover: Micro Ribbon plug-in type.
Mating receptacle: Amphenol #57-20140 or similar.
INSULATION RESISTANCE: 100 megohms min.
VIBRATION: .065" excursion 10-55 cps. 10g 55-550 cps. upon request.
SHOCK: 30g according to Mil-R-5757C upon request.
TEMPERATURE RANGE: −55°C to +85°C.
WEIGHT: 1.2 ozs. (open) 2.0 ozs. (sealed).
PULL-IN SPEED: Approximately 15 ms at nominal voltage.
DROP-OUT SPEED: Approximately 10 ms at nominal voltage.
CONTACTS: 3/32 silver.
CONTACT ARRANGEMENT: 4 pole, double throw (4 Form C).
COIL POWER: 3 watts max. DC @ 25°C. Continuous duty.

P&B Representatives in Canada: Aeromotive Engineering Products, Montreal
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PRINCETON, INDIANA

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A technician focuses on a cold-reduction mill roll to study bearing condition.

A camera that can see the temperature

Requiring no external illumination it will read to within 1 deg C

Blast furnaces, open hearths, coke ovens and other steelmaking facilities appear in all the colors of the rainbow through the lenses of the evaporograph, a type of camera used (for the first time in the steel industry) by the United States Steel Corporation.

Developed by Baird-Atomic, Incorporated, as a direct thermal-imaging device, the new instrument (it was discussed in the May 1956 issue of Design Engineering) functions as efficiently in absolute darkness as in daylight, requiring no source of external illumination. Instead, it forms a colored, two-dimensional image by using the long-wavelength, infrared radiation emitted from the object or area being photographed. The image is made visible by a light source inside the instrument. Sensitivity of the device is such that differences of as little as 1 deg C can be detected in the target temperatures. It will function as long as the target temperature is above absolute zero and there is a temperature difference existing in the field of view. Objects as far away as 3 miles or more will register accurately on Eva, as it is called.

Test observations and color photographs made with the instrument throughout the mill area have shown that temperature differences on the exterior surface of high-temperature operating units make possible the study of interior wall conditions in open hearths and blast furnaces. Thus, the evaporograph answers a long-time need of operation and maintenance departments in steel mills. It shows promise also as a detector of hot-spots or worn areas in machinery, steam lines and other auxiliary mill equipment, where temperature is a measure of interior conditions.

The heart of the new instrument is the evaporograph cell, a vacuum enclosed membrane on which a thin film of oil condenses.

The membrane is made of nitrocellulose about 4 micro-in. (0.000004 in.) thick, mounted on a metal ring. When the membrane is illuminated with white light, interference between the light reflected from the front and rear surfaces of the membrane has the effect of canceling certain wavelengths in the incident light and gives the membrane a colored appearance. The thickness of the membrane is controlled so that it becomes yellow.

One side of the membrane is lightly blackened with

New Products
Continued

Humidity indicator

An easy-to-use and extremely versatile remote humidity indicator (designed for measuring the humidity of closed areas) is now available from **Serdex, Inc.** The unit has wide application in the laboratory, for research and in-plant operations.

The indicator can be located in office, laboratory or control room away from the area to be measured. An air line is run into the area to be sampled. A vacuum pump or line draws sampled air through the indicator.

It is easy to instal this instrument. Only two connections are neccessary — one from the inlet at the bottom of the indicator case to the air line from the container or area sampled, the other from and outlet at the top of the case to a vacuum pump or line. No wiring is needed, since operation is mechanical. No conversion charts are necessary. For production use, the indicator can be installed permanently to give continuous humidity readings. (224)

Phosphor bronze

Technical bulletin (T-4), describing the advantages of Flexograin, a finegrain phosphor bronze, is now available from **Riverside-Alloy Metal Division,** H. K. Porter Company, Inc. The 4-page bulletin explains why it is superior to the coarser-grained phosphor bronze for many applications.

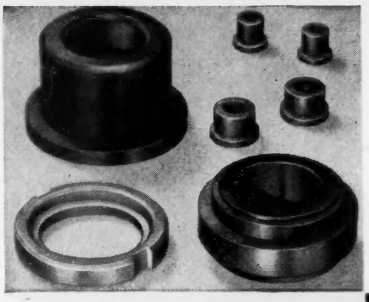
Besides showing microscopic photographs demonstrating the difference between Flexograin and commercially-available phosphor bronzes, the bulletin also presents graphic illustrations of various applications. (225)

Air cleaner

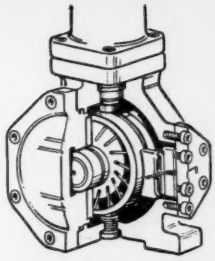
An electronic air cleaner, which is cheaper to own and operate than some mechanical filter systems and up to 20 times more efficient, has been announced **by B. F. Sturtevant Company,** a Canadian Westinghouse subsidiary.

The new unit is less than half the size of standard electronic air cleaners, yet is equal in efficiency and has increased air handling capacity. Developed specifically to fit the needs of commercial buildings, the Precipitron (as it is called) will also give savings of up to 35% over previous costs for electronically cleaned air. Installation costs of the new model have been drastically reduced through the elimination of conventional cell-to-cell high-voltage wiring and the need for specifically constructed foundations. (226)

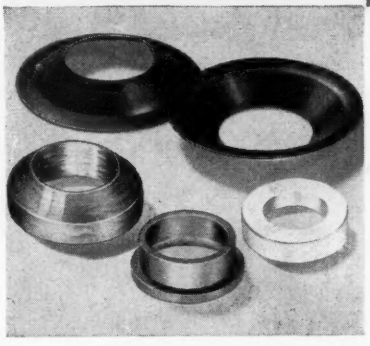
Continued on page 106

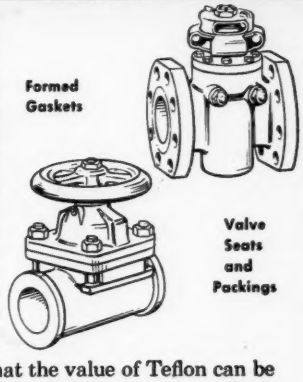


FOR:
Guide Bushings, Vanes and Wear Rings



HAVE YOU CONSIDERED THE IMPORTANT ADVANTAGES OF FILLED TEFLON*?





It has been definitely established that the value of Teflon can be considerably enhanced by the use of fillers in certain applications. Laboratory and field experience has demonstrated that the use of fillers permit Teflon to be more readily tailored to a wide variety of chemical, electrical and mechanical applications. Also, some mechanical properties can be improved. These include:

1) resistance to deformation under load
2) resistance to wear
3) thermal conductivity
4) compressive strength
5) hardness

By thus improving its properties, Teflon now offers even greater industrial potential. This is the reason filled Teflon has become an important item in the "John Crane" Chemlon® line of better Teflon products.

Chemlon is available with such fillers as glass fiber, carbon, graphite, copper and bronze, talc, calcium fluoride and other inorganic materials.

Tell us about your requirements. We'll tell you the advantages you can get from filled Chemlon. Request Bulletin T-104.

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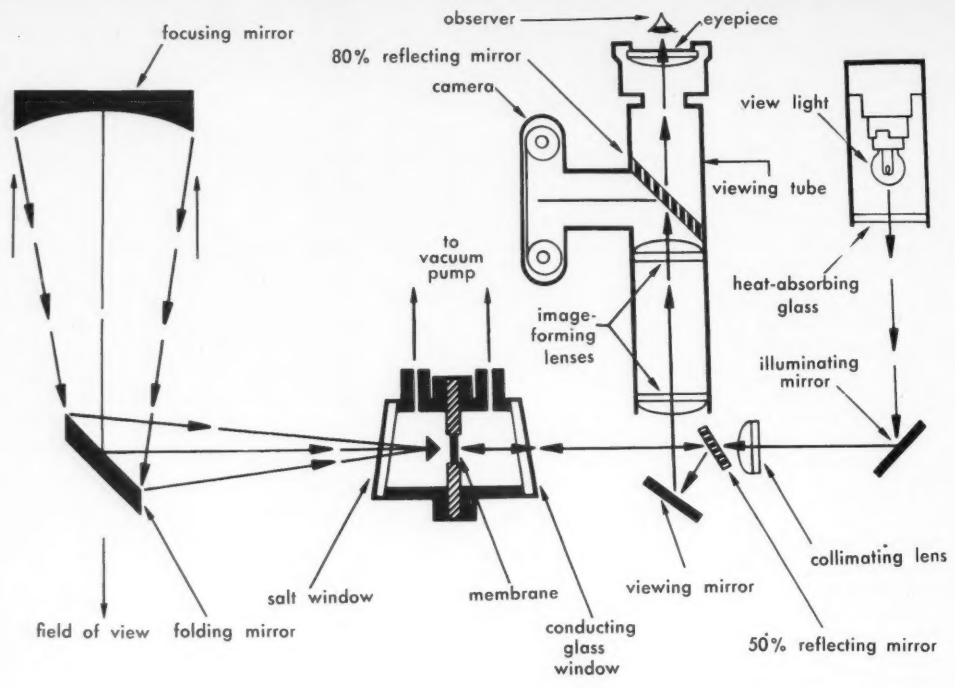

The Optical System

The infra-red optical system of the evaporograph is comparatively simple, consisting of a 4 in. diameter, spherical, front-surface mirror (with an 8 in. focal length), mounted to move along its axis to focus the image on the membrane. It is adjustable for distances from 10 ft. to infinity. A flat mirror in front of the spherical mirror is mounted at an angle of 45 deg and serves to reflect the infra-red image into the evaporograph cell.

The viewing optical system is equipped with a light source which illuminates the membrane uniformly and forms an image of the membrane both on photographic film and in an eyepiece for direct observation.

Light from the special bulb passes first through a piece of heat-absorbing glass and is then reflected by a mirror in a direction at right angles to its original path. This light passes through a collimating lens which illuminates the membrane through a semi-transparent mirror.

The light is then reflected by the membrane to another mirror and passes down the viewing tube in a right-angle direction to the axis of the cell. Two lenses in this tube form an image of the membrane surface. A partially-reflecting mirror placed in the path of this light serves to split the beam into two parts. One beam forms an image on the film of a built-in 35-mm camera: the other forms a true image of the membrane on the back of the mirror. This image is observed and photographed.

vaporized gold, deposited under high vacuum to absorb the energy incident upon the membrane from that side. The membrane is then mounted in a cell with the coated side toward the infrared optical system. This side of the cell is sealed with a sodium chloride window which will admit radiation up to a wavelength of approximately 19 microns.

In use, air is evacuated from the cell and the rear half is heated slightly to increase the vapor pressure of the oil. Just as water condenses on a cold glass in hot weather, so does the oil start to condense on the nitrocellulose membrane.

If the image of an object is focused on the blackened side of the membrane, different portions of it (the membrane) will be at different temperatures because of variations in the infrared radiations from the target. The oil will condense (if it can) on the cooler portions of the membrane. This variable condensation causes variation in the thickness of the oil film, which in turn changes the apparent color of each temperature-differential area of the membrane. Thus, the heat image focused on the membrane becomes visible and distinguishable through the different interference colors formed by the oil film. An oil slick on water exhibits the same colors.

By employing a reference temperature in the field of view, the evaporograph can be used to calculate unknown temperatures. By comparison of colors on the membrane, differences of temperature in the target area are readily seen.

Thus, the new device serves the dual purpose of making temperature differences visible. ★

By the way . . .
how old are your drawing tables?

Chances are that the design is probably a CENTURY old . . . or even older!

Working with such obsolete and clumsy equipment, to reach the different parts of the drawing, the draftsman has to bend . . . stretch . . . crawl on his board, and climb or kneel on his stool . . .

WHO can expect efficiency from such an awkward position?

WHO can sustain such a position for more than a few minutes without taking a rest?

WHO can find pleasure and satisfaction in their work under such conditions?

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The amazing adjustability of UNIC permits the draftsman to work in perfect comfort at all times, preventing "Professional Diseases."

In improving a draftsman's comfort and health and also the office appearance, UNIC also increases production by 10% to 20% ON OVER-ALL TIME, which means a saving of $600.00 to $1,200.00 per year per each UNIC drafting table.

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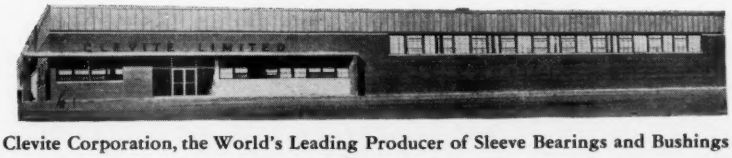
Clevite Limited, the only major Canadian manufacturer of sleeve-type bearings and bushings, also makes sintered bearings and shapes, Silentbloc rubber-and-metal bushings, and all major products of Cleveland Graphite Bronze and Clevite Harris. We regularly supply outstanding engineering and field service to the automotive, farm equipment and appliance industries. Our engineers are at your service, too. Write or call Clevite Limited, St. Thomas, Ontario.

Do you use bushings in quantity? Our split rolled bushings can mean improved performance and lower costs, particularly as compared with cast bronze types.



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1/100 — 10 H. P.
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New products

Continued

Force gauges

A series of mechanical force gauges capable of holding the maximum reading after the load has been removed have been developed by **Hunter Spring Company.** Similar to the company's standard precision force gauges the eighteen new units have a range of measurement capacities of from 0-500 gm to 0-200 lb.

The instruments are ideal for making force measurements, both in tension and compression, especially in awkward positions where it is difficult to read the gauge in the measuring position, where measurements cannot be held steady and for measuring such momentary loads as peaks and break-points.

A single control button selects the desired gauge operation, either to hold the maximum reading or to follow all load fluctuations. If set to record maximum load, the dial pointer remains at that reading until released by a touch of the button. Since only one pointer is used there is no follower hand to be reset after each measurement. Thus, if a maximum force has been recorded, the gauge is simply released and reset for the next measurement by a flick of the control button. (227)

Powder blower

A completely self-contained, portable unit is now available for the proper application of dry **Magnaflux** powder. The No. 58600 powder blower operates directly from any air line and requires only 20 psi. A simple adjustment controls the density of the cloud of powder, and two push buttons permit selection of either powder or clean air. By holding the gun level (and at a distance from the area being tested) the particles gently flood the entire area, showing clear indications when cracks are present.

This new blower is extremely compact and weighs only 2¼ lb empty. It is simple to operate and has advantages over the shaker-type powder bulbs in that it is faster, covers a wider area and distributes the particles evenly. (228)

Switchboard instrument

A switchboard instrument for easy reading at greater than 120 deg angles (surpassing ASA readability standards by 200%) has been announced by **Canadian General Electric Limited.**

The new instrument is particularly useful for utility and mill installations where distant angular readings must be taken and maximum legibility is essential. It can also be used for general switchboard service, control panels and special test equipment.

The greatly increased angle of readability makes the instrument ideal for use on swinging brackets or other installations that are necessarily remote from the observer. (229)

Adjustable motor base

Lost production due to stretched and sagging belts has been virtually eliminated by the **American Pulley Company's** Adjusto-Slide motor base. With this base, belt take-up is accomplished by adjusting only one screw, an adjustment that is safely made without even stopping the motor.

Replacement of belts is just as simple, for the adjusting screw on most models can be loosened and swung aside, allowing the top plate and the motor to move far enough for removal of the old and installation of the new belt. Once the new belt is in place, the motor is moved back in place, the adjusting screw swung back, tightened and the machine is back in operation. (230)

Back pressure valve

A catalogue sheet available from **Atlas Valve Company** describes their No. 1605 spring-loaded dual purpose relief and back pressure valve, designed to function on both condensing and noncondensing systems.

In condensing systems the valve is used to maintain constant back pressures in the exhaust line from an auxiliary engine or turbine. On the condenser of any auxiliary equipment it functions as a relief valve if the vacuum is lost. In noncondensing systems it serves as a back-pressure control valve. (231)

Contactors

The relay division of **J. R. Longstaffe Co., Ltd.** announce that the new Struthers-Dunn Type 48KXX (3 pole) and 48LXX (4 pole) contactors are now available.

These units are single-unit versions of the popular Type 175KXX mechanically interlocked reversing contactor that has proved its reliability in severe motor reversing applications such as hoists, motorized valves, window and door openers and so forth.

Small, yet ruggedly built for long, trouble-free operation, these contactors are exceptionally well-suited to built-in motor control applications. Fine silver, double-break contacts in melamine arc chutes afford a generous safety factor under high overload conditions. All coil and contact terminals are readily accessible from the front for easy installation, even with heavy-gauge wire. Heavy mounting plates offer rigid support and resist any torsional strain that might cause misalignment. (232)

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Gives you these properties:

UCC Ability to withstand temperatures from—70° to over 400°F. makes Silicone rubber useful in situations where organic rubber would crack or melt, such as oven door gaskets, aircraft seals, etc.

UCC Resistance to oils and chemicals, coupled with an extremely low compression set, makes Silicone rubber ideal for seals and gaskets in pumps and other machinery handling chemical products.

UCC Due to its excellent insulating properties and high resistance to weathering, Silicone rubber is used as electric cable covering.

UCC The unique property of electrical conductivity in Silicone rubber is now available in Union Carbide's new K-1516 Silicone rubber compound.

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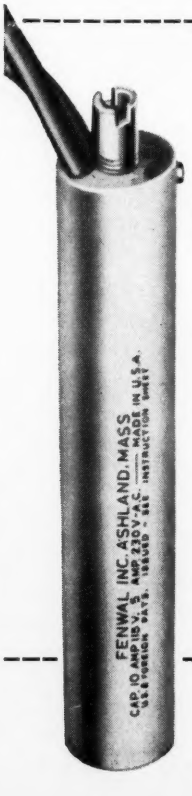

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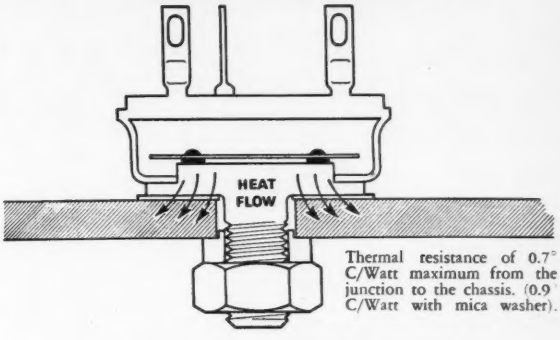


Thermal resistance of 0.7° C/Watt maximum from the junction to the chassis. (0.9° C/Watt with mica washer).

with Honeywell's new H 10 Weld-Seal

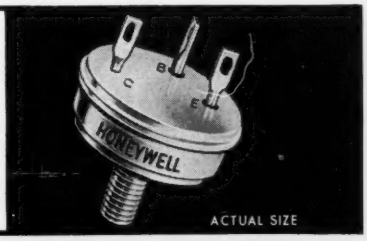
Honeywell's new "H 10" Weld-Seal has a larger collector area for more rapid heat dispersion . . . *gives you lowest thermal resistance of any transistor.*

The new "H 10" allows delivery of 10 watts to a servo motor in an ambient of 85°C. Long thermal time response of juction temperature and lowest ever thermal resistance make overload possible for a longer period of time without permanent damage to transistor.

Honeywell's new "H 10" is hermetically sealed by welding . . . so you can build ruggedness and durability into your equipment. And of course you get all the other advantages which have made Honeywell Weld-Seal transistors famous . . . high and uniform power gain of a wide range of collector currents, long life, outstanding stability and economy.

For complete information, contact your nearest Honeywell office, or write direct to Honeywell, Toronto 17, Ontario.

Typical "H 10" operating characteristics:
Transconductance : .9 at 10 amps
Current gain: 18 at 10 amps
Maximum collector current: 15 amps



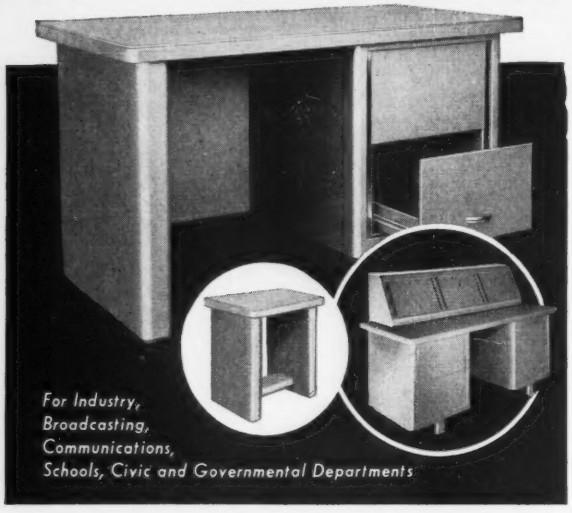
ACTUAL SIZE

Honeywell
H HONEYWELL *First in Controls*

HAMMOND

presents a new line of

CONSOLES • TURRETS • EQUIPMENT TABLES



SINGLE, DOUBLE AND TRIPLE CONSOLES: . . . of heavy gauge steel, beautifully finished in beige-brown or gray "Hammerlin". Tops are covered in colour keyed linoleum, and bright metal moulding conceals all mounting screws. Single and double models have one 10½" x 19" panel and a sliding drawer of the same size. Triple Consoles have three panels and one drawer. All models have 21" removable, rear panels.

SINGLE, DOUBLE AND TRIPLE EQUIPMENT TABLES: . . . produced in the same materials and finish as the console models. The three standard sizes are suitable for carrying a variety of equipment.

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complete data bulletin 5060 sent on request

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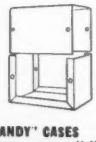

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UTILITY CASES: For portable equipment, and prototype development.

CABINET AND RACK PANELS: Exclusive Hammond alloy, works, punches, drills cleanly; also in steel.

EQUIPMENT CABINETS: Give "original" equipment a professional look.

STANDARD RELAY RACKS (floor type): Mounting alignment is retained under extreme equipment loads.

Hammond also specializes in "original" equipment built to your own design. For further information contact —

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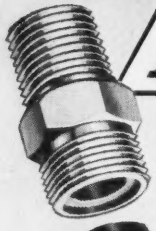

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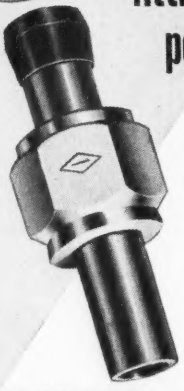
The flareless tube fitting that makes a positive butt-joint



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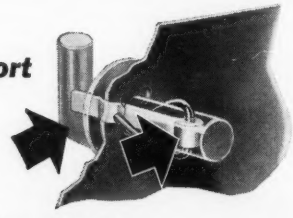

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The design flexibility of Spring-Lock shelf supports may be applied to a variety of uses...washer cover knobs, drawer pulls and others. Spring-Locks cut material and assembly costs, too. No special tools, bolts, nuts or threadings needed. Just a half-turn locks them securely; another half-turn provides for removal. Write for 40-page catalog and samples.

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1776 North Broadway, Albany 1, N. Y.

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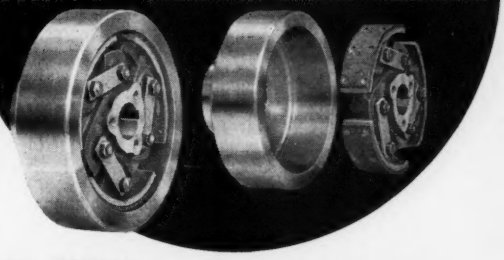
176	Victor Mfg. & Gasket Co.	15
177	Wagner Electric Division of Sangamo Company Ltd.	2
178	Wallace Barnes Co. Ltd.	41
179	Weatherhead Company, The	11

Flexible
ACTION IN THE
New HILLIARD
TWIFLEX
AUTOMATIC CENTRIFUGAL CLUTCH COUPLING



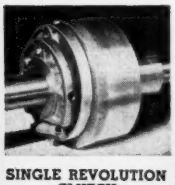
11 NEW IMPORTANT FEATURES . .

1. Flexible in all directions.
2. Absorbs Shock.
3. Limits torsional vibration.
4. Has adjustable idle speed
5. Can be furnished in automatic free-wheeling type.
6. Smooth starting.
7. No slip under normal load at full speed.
8. Protects driver and driven mechanisms against overload shock.
9. Can be furnished in automatic backstop type.
10. Prevents torsional resonance.
11. Easily assembled even in blind installations.

If you have problems of misalignment - smooth starting - vibration - overload - or assembly in the manufacture or operation of:

- Compressors
- Blowers
- Diesel Engines
- Excavators
- Refrigeration
- Hammer Mills
- Textile Machinery
- Wire Machines
- Fans
- Gasoline Engines
- Back Stop Brakes
- Mixers
- Conveyors
- Pumps
- Electric Motors
- Generators
- High Speed Pulverizers
- Tube Mills

- Let Our Engineers Consider Your Problem. Twiflex May Be The Answer.

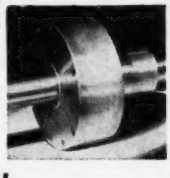


OVER-RUNNING CLUTCH

For automatic engagement and release on two speed drives, dual drives and for ratchet feed or backstop action.
Write for Bulletin 231.

SLIP CLUTCH

For overload protection — constant torque — constant tension on reeling or winding stands.
Write for Bulletin 300.



SINGLE REVOLUTION CLUTCH

For automatic, accurate control, electrically or mechanically, of intermittent motion, indexing, cycling, cut-off.
Write for Bulletin 239.

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Editorial

Keeping Abreast of the Times

The season for society conventions is now in full swing and a most important meeting, the 12th Annual Instrument-Automation Conference and Exhibit, was held last month in the Cleveland Auditorium.

The impressive array of instruments—$500 million of them—and the technical papers by leading instrument engineers, emphasized the vital role played by instrumentation in present day industry.

The theme of the conference was "Instrumentation for Systems Control." Dr. Robert J. Jeffries, I.S.A. President-elect-Secretary explained in his welcoming address that the almost-sudden development of this new field of engineering-science, sometimes called Systems Engineering, sometimes called Automation, always reduces in its essence to instrumentation. It is making it possible to do the impossible, that is, to extend the range of man's senses to increase his capabilities for memory, calculations and physical force.

This month in Toronto there will be the I.R.E. Canadian convention (details of which appeared in last month's Design Engineering) and the combined A.S.L.E. - A.S.M.E. meeting (see elsewhere in this issue). These meetings are all most interesting and very necessary for a full interchange of information. Their only disadvantage is that they are so time consuming for the busy engineer.

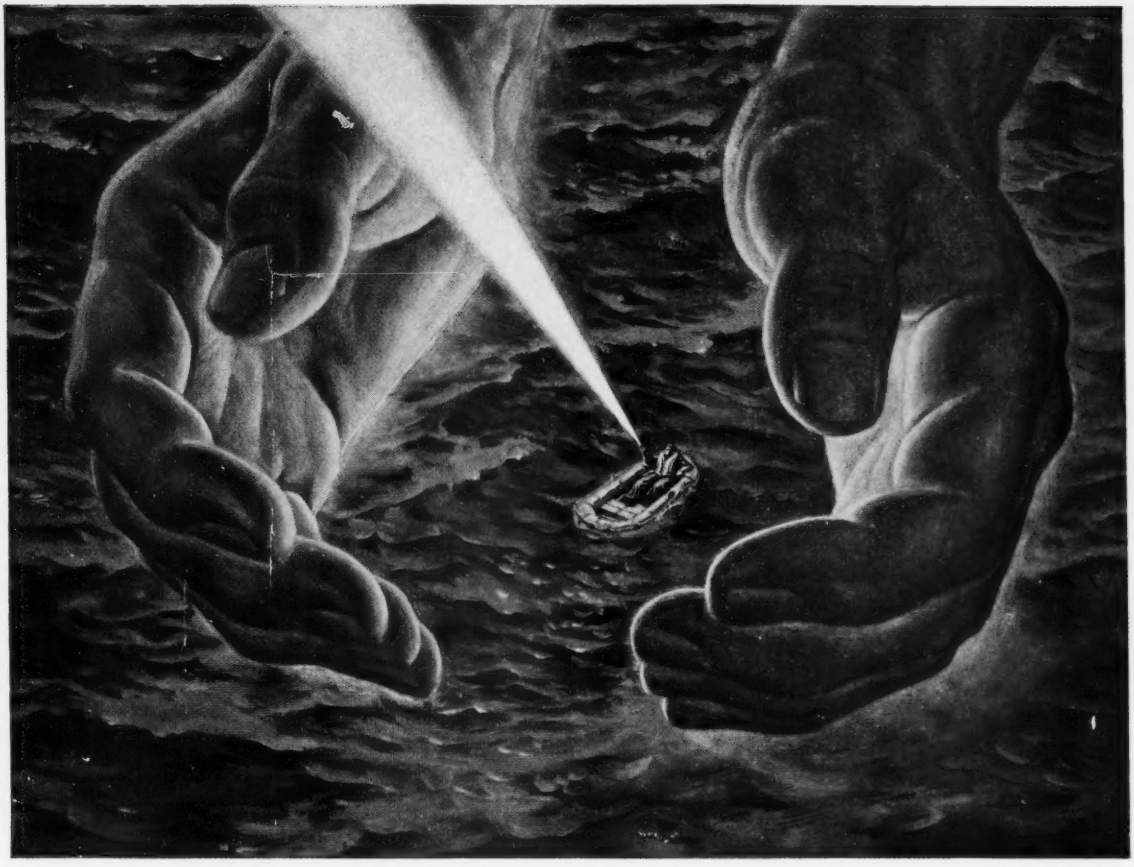
It is for this reason that the editors of Design Engineering try to take in as many meetings as possible, not with the idea of giving a stand-by-stand coverage, but so that they can incorporate information gleaned from them in the editorial pages and so keep the magazine right up-to-date.

Welding Education:

Canadian delegates to European welding conferences report that great interest has been taken by educational authorities in Canadian methods of welding education, particularly the highly developed system of Home Study, a method which has not yet been attempted anywhere else.

The advantage claimed for such a course is that it enables a large number to participate at one and the same time and also permits students in any part of the country to enroll, even if they are not near a centre of technical education. It seems to us, however, that an essentially practical subject like welding must be very difficult to learn without an instructor.

William Moore.



To Save a Life

Portable packages of electricity help make our lives safer and more enjoyable

THE BRIGHT BEAM of a flashlight in the hands of an airman down at sea . . . the untold comfort of an almost invisible hearing aid . . . the pleasure of listening to your favorite music over a portable radio.

THESE INGENIOUS DEVICES have one thing in common—they all get their electric power from dry-cell batteries. Each day millions of Canadians depend on these portable packages of power for greater safety, comfort, and pleasure.

LARGE BATTERIES furnish power for signalling and communications systems. Hearing aid batteries are now so tiny that they can hide under a dime. Other dry-cells supply power to everything from toys to Geiger counters.

MANY YEARS AGO, the people of Union Carbide produced the first commercial dry-cell. From this beginning, they developed the great variety of EVEREADY batteries that now serve dependably in so many applications.

DEVELOPMENT ENGINEERS at Union Carbide are constantly working on new, improved methods of producing packaged power. Their goal is to make dry-cell batteries do even more work for all of us.

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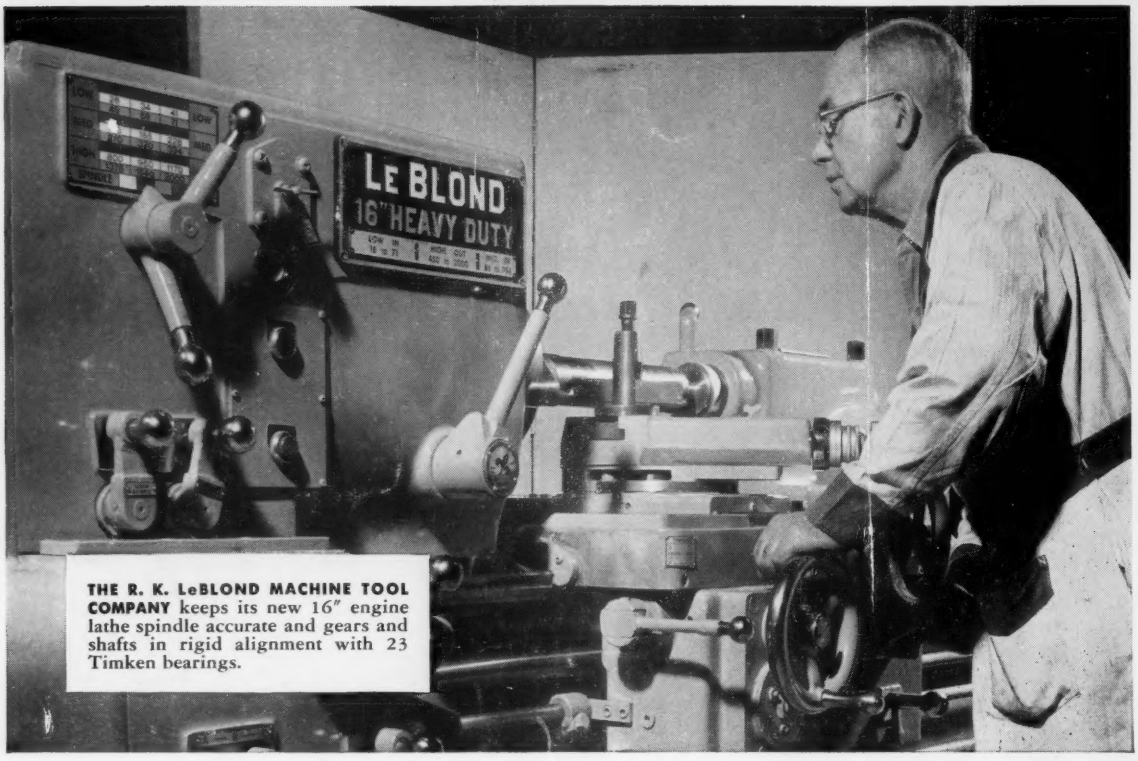

THE R. K. LeBLOND MACHINE TOOL COMPANY keeps its new 16″ engine lathe spindle accurate and gears and shafts in rigid alignment with 23 Timken bearings.

16 or 2000 RPM—23 TIMKEN bearings take varying loads on LeBLOND 16″ engine lathe

EFFICIENT carbide turning was the goal when The R. K. LeBlond Machine Tool Company built their 16″ engine lathe. That meant high precision at low as well as high speeds; high rigidity for smooth hogging or fine finishing. To take the heavy cutting loads and still maintain precision they mounted the spindle on two single-row cone adjusted Timken tapered roller bearings at the front and one two-row cone adjusted Timken bearing at the center position. Twenty more Timken bearings keep gears and shafts aligned in the 27-speed headstock and in the tailstock. To compensate for differential expansion between starting temperature and operating temperature and at varying operating speeds, the new Timken high-speed mounting was used to contain the center spindle bearing. The LeBlond Company says the new 16″ engine lathe is the most rugged yet precise machine they have ever built.

Wherever wheels and shafts turn, Timken bearings are the standard of excellence. They virtually eliminate friction. Their full line contact insures extra load carrying capacity. They're engineered to give true rolling motion; and they're precision manufactured to live up to their design. We even make our own steel to insure the highest quality.

When you buy or build machines, make sure you specify Timken tapered roller bearings. They're your No. 1 bearing value. The Timken Roller Bearing Company, Canton 6, Ohio, U. S. A. **CANADIAN PLANT:** St. Thomas, Ontario. Cable address: "TIMROSCO".

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